European Potato Journal

EUROPÄISCHE ZEITSCHRIFT FÜR KARTOFFELFORSCHUNG
REVUE EUROPÉENNE DE LA POMME DE TERRE
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EUROPEAN ASSOCIATION FOR POTATO RESEARCH

EUROPÄISCHE GESELLSCHAFT FÜR KARTOFFELFORSCHUNG

ASSOCIATION EUROPÉENNE POUR LA RECHERCHE SUR LA POMME DE TERRE

Aims – To promote the exchange between the various countries of scientific and general information relating to all phases of the potato industry and to encourage and assist international co-operation in the study of problems of common interest in this field. These aims are to be achieved through the setting up of subject sections for the the study of specialized problems; the holding of an international conference in a different country every three years; by publishing the European Potato Journal.

Ziele – Austausch von wissenschaftlichen und allgemeinen Informationen in Bezug auf alle Fragen der Kartoffel zwischen den verschiedenen Ländern; Förderung der internationalen Zusammenarbeit an der Erforschung von Problemen von allgemeinem Interesse auf diesem Sektor. Die Gesellschaft sucht diese Aufgaben zu erfüllen durch Aufstellung von Fachgruppen zur Bearbeitung bestimmter Probleme, Veranstaltung internationaler Tagungen alle drei Jahre im Wechsel in verschiedenen Ländern, Herausgabe der Europäischen Zeitschrift für Kartoffelforschung.

Buts – Promouvoir l'échange d'informations d'ordre scientifique ou d'ordre général relatives à toutes les phases de l'industrie de la pomme de terre entre les différents pays d'Europe et encourager et faciliter la coopération internationale dans l'étude des problèmes présentant un intérêt commun dans ce domaine. L'Association se propose de poursuivre ces buts en créant des groupes de spécialistes pour l'étude des problèmes spécialisés, en tenant une conférence internationale dans des pays différents tous les trois ans et en publiant la Revue Européenne de la Pomme de Terre.

Membership – Members of the Association may be Ordinary (personal) Members or Sustaining Members. The annual subscription for Ordinary Members is 20 Dutch guilders and for Sustaining Members 250 Dutch guilders (or the equivalent in other currencies). Both will receive the European Potato Journal free of charge.

Mitgliedschaft – Die Gesellschaft besteht aus ordentlichen Einzelmitgliedern (natürlichen Personen) und fördernden Mitgliedern. Der jährliche Mitgliederbeitrag für Einzelpersonen beträgt 20 holl. Gulden und für fördernde Mitglieder 250 holl. Gulden (oder Gegenwert in anderer Währung). Beide erhalten die Europäische Zeitschrift für Kartoffelforschung kostenfrei.

Membres – Les membres de l'Association peuvent être soit des membres ordinaires, qui sont obligatoirement des personnes physiques, soit des membres bienfaiteurs. La cotisation annuelle des membres ordinaires est fixée à 20 florins hollandais et des membres bienfaiteurs à 250 florins hollandais (ou l'équivalent en autres devises). Tous recevront la Revue Européenne de la Pomme de Terre sans frais supplémentaires.

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Sveriges Bränneriidkareförening u.p.a. (Alcohol manufacture), Kristianstad, Sweden.

Sveriges Potatisodlares Riksförbund, Stockholm, Sweden.

Sveriges Stärkelseproducenters Förening (Potato starch), Karlshamn, Sweden.

Kartoffeleksportudvalget (Danish Producers and Exporters Potato Union), Axelborg, Copenhagen V, Denmark.

Aktieselskabet De Danske Spritfabrikker (Danish Destilleries Ltd, Production of alcohol and yeast), 29 Havnegade, Copenhagen, Denmark.

Karl Bedsted (potato merchant, sugar beets, agricultural chemicals), Erik Glippingsvej 6, Viborg, Denmark.

"Buris" Potato Export (Johan Chr. Hansen, potato export), Bur, Denmark.

Dansk Andels Gødningsforretning (Danish Cooperative Fertilizer Association D.A.G.; Trade in fertilizers), Axelborg, Copenhagen V, Denmark.

Det Danske Gødningskompagni A/S (Manufacturing and sale of Fertilizers and Chemicals), Amaliegade 15, Copenhagen K, Denmark.

Kartoffelmelscentralen A.m.b.A. (Central office of the Federation of Starch Factories in Denmark, wholesale trade: potato starch), Vesterbrogade 6 D, Copenhagen V, Denmark.

E. Lunding A/S (Import of Fertilizers), Gl Kongevej 1, Copenhagen V, Denmark.

Sajyka A.m.b.A. (Co-operative organization in growing and sale for export of seed- and ware potatoes), Herning, Denmark.

Sydjyks Kartoffeleksportforening A.m.b.A. (Export organization of southern Jutland, potato export, potato trade), Brørup, Jutland, Denmark.

Kon. Genootschap voor Landbouwwetenschap (Royal Society for Agricultural Science in the Netherlands), Wageningen, Netherlands.

Produktschap voor Aardappelen (Potato Marketing Board), The Hague, Netherlands.

N.V. Aagrunol (Factories for plant protection chemicals), Oosterkade 10, Groningen, Netherlands.

Berends N.V. (Potato washing plant), Nieuw Amsterdam, Netherlands.

N.V. Ingenieursbureau „Kracht" (Advice and installment of stores for agricultural and horticultural products; cooling and drying equipment) Koningsplein 36, The Hague, Netherlands.

Instituut voor Bewaring en Verwerking van Landbouwprodukten (Institute for storage and processing of agricultural products), Wageningen, Netherlands.

Instituut voor Plantenziektenkundig Onderzoek (Institute for phytopathological research), Wageningen, Netherlands.

Lockwood Graders Holland N.V. (Factory for potato machines), Nieuw Amsterdam, Netherlands.

Wolf en Wolf N.V. (Exporter of seedpotatoes), Martinikerkhof 5, Groningen, Netherlands.

N.V. Philips-Roxane (Pharm. Chem. Industrie [Duphar]), P. C. Hooftstraat 171–177, Amsterdam, Netherlands.

Hettema Zonen N.V. (Export of seed and ware; breeding; multiplication fields for seed; representative for Dutch and foreign breeders), Leeuwarden, Netherlands.

„Conservatome" (recherce et exploitation de tous procédés et appareils destinés à la conservations des produits), 18 rue Séguin, Lyon, France.

Fédération Nationale des Producteurs de Plants de Pommes de Terre, 14 Rue Cardinal Mercier, Paris IX^{e}, France.

Vereinigung Schweiz. Versuchs- und Vermittlungsstellen für Saatkartoffeln (VSVVS), Winterthur, Switzerland.

Schweiz. Saatzuchtverband, Solothurn, Switzerland.

Ragis – Kartoffelzucht- und Handelsgesellschaft m.b.H. (Züchtung von Speisekartoffeln für das Inland und für den Export), Neue Sülze 24, Lüneburg, Hannover, Deutschland.

EUROPEAN POTATO JOURNAL

EUROPÄISCHE ZEITSCHRIFT FÜR KARTOFFELFORSCHUNG

REVUE EUROPÉENNE DE LA POMME DE TERRE

Composition of the Journal: – Original contributions on fundamental and practical potato research, surveys of literature, letters to the Editor, news and reviews.
A volume of the Journal consists of four issues published in the same year and contains at least 240 pages. Papers are in English, German or French with summaries in at least these three languages.

Zusammenstellung der Zeitschrift: – Originalbeiträge über grundlegende und praktische Fragen der Kartoffel, Sammelreferate, Briefe an die Schriftleitung, Buchbesprechungen, Mitteilungen. Ein Jahrgang der Zeitschrift besteht aus vier Heften, jeder Band umfasst mindestens 240 Seiten. Die Beiträge sind in Englisch, Deutsch oder Französisch mit Zusammenfassungen in mindestens diesen drei Sprachen.

Composition du Journal: – Publications originales sur des recherches fondamentales ou pratiques concernant la pomme de terre, mises au point et analyses, communications à l'éditeur, avis.

Chaque volume du Journal comprend quatre numéros publiés au cours d'une année et contient au moins 240 pages. Les articles sont en anglais, allemand ou français avec des résumés en au moins ces trois langues.

Subscription to non-members: 25 Dutch guilders (or equivalent in other currencies).
Bezugspreis für Nichtmitglieder: 25 holl. Gulden (oder Gegenwert in anderer Währung).
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All correspondence should normally be addressed to the Editor, P.O. Box 20, Wageningen, Holland.

Alle Korrespondenz ist in der Regel zu richten an den Schriftleiter, P.O. Box 20, Wageningen, Holland.

Toute la correspondance doit être normalement adressée à l'éditeur, P.O. Box 20, Wageningen, Holland.

(*Continued at the end of this journal*)

European Potato Journal

EUROPÄISCHE ZEITSCHRIFT FÜR KARTOFFELFORSCHUNG
REVUE EUROPÉENNE DE LA POMME DE TERRE

VOLUME 1 NO. 1 MARCH 1958

THE ORIGIN AND AIMS OF THE EUROPEAN ASSOCIATION FOR POTATO RESEARCH

A. R. WILSON

Scottish Horticultural Research Institute, Mylnefield, Invergowrie by Dundee

Summary in Fr. & G, p. 4

THE FIRST INFORMAL CONFERENCE AT AALBORG (1951)

During the Second World War and the immediate post-war years, a number of countries in Europe initiated programmes of research directed towards improving methods of storing potatoes. Between 1946 and 1950, interchange of views, both by correspondence and at casual meetings, between individuals working in this field proved so helpful that DR. N. H. H. ADDENS and DR. W. H. DE JONG (the Netherlands), Mr. T. FREDERIKSEN (Denmark) and DR. A. R. WILSON (United Kingdom) decided that an informal conference on storage problems should be held in Aalborg, Denmark, in 1951. This conference, which was organised by MR. FREDERIKSEN, was attended by workers from Denmark, the Netherlands, Sweden and the United Kingdom. As those who attended were unanimous in their opinion that the meeting had been of considerable value, it was decided to hold such conferences biennially, working round the participating countries in rotation.

THE SECOND INTERNATIONAL INFORMAL CONFERENCE ON POTATOES AT SUTTON BONINGTON (ENG.) IN 1953

The second meeting was organised by DR. WILSON and held at Sutton Bonington, England, in 1953, under the title „Second International Informal Conference on Potatoes". As the title implies, a wider range of subjects was included in the programme than at the previous meeting. This seemed desirable because storage problems are so often complex and involve research in many different fields. Workers from the German Federal Republic were present at Sutton Bonington in addition to a number from all the countries represented at the first conference.

THE THIRD INTERNATIONAL INFORMAL CONFERENCE ON POTATOES AT WAGENINGEN (NETH.) IN 1955

The third conference was organised by DR. DE JONG and held in Wageningen, the Netherlands, in 1955. This meeting was attended by over fifty workers from the five countries mentioned above. Many of those present expressed the opinion that because of the paramount importance of the crop in most parts of Europe and because of the similarity of many of the problems facing the various countries, there was a real need for even wider contact of this kind. It was pointed out that these conferences had given specialists a chance to discuss their problems with those working in other fields, against the background of the crop as a whole, a thing which was not possible at the more usual type of international gathering organised on a subject rather than a crop basis.

On 10th August, 1955, during the field excursion following the Third Conference, a meeting was held at the Hotel Amicitia, Leeuwarden, to discuss future plans. At that meeting, motions were carried,

(1) that a European Association for Potato Research, open to all countries and covering all subjects, be formed to take over and expand the functions of the Informal Conferences and,

(2) that the Association, when formed, should publish a „*European Potato Journal*" on the general lines of the *American Potato Journal.*

The main argument brought forward in support of the latter motion was that the results of a considerable proportion of the potato research carried out in Europe, particularly on the Continent, do not reach many who might be interested, partly through language difficulties and partly through their publication in a wide range of periodicals and reports, some of which are not readily available. A number of speakers stressed the usefulness of the *American Potato Journal* in bringing together much of the American work, especially applied research, into one publication. It was felt by many that a European journal on similar lines would be very valuable to all concerned (both scientifically and commercially) with the crop. Both proposals were strongly supported by PROFESSOR ORA SMITH of Cornell University, representing the Potato Association of America, who attended the meeting, and subsequently by that Association itself at its Annual General Meeting in East Lansing, Mich. in September, 1955 (*Amer. Potato J.*, 32 (1955) 433). Before the Leeuwarden meeting closed, an „*Interim Council*" was appointed to work out the detailed means of implementing the decisions made. This body consisted of DR. B. EMILSSON (Sweden), PROFESSOR DR. O. FISCHNICH (German Federal Republic), MR. F. HANSEN (Denmark), DR. W. H. DE JONG (the Netherlands) and DR. A. R. WILSON (United Kingdom).

During the next two years the difficulties surrounding the foundation and organisation of both the formal Association and the Journal were gradually resolved in correspondence between the various members of the Interim Council and at meetings held in England (1956), the Netherlands and Sweden (1957). At the last of these meetings the final draft of the Constitution was agreed.

THE FOURTH INTERNATIONAL CONFERENCE ON POTATOES AT LUND (SW.) IN 1957

The fourth meeting was organised by DR. EMILSSON and held in Lund, Sweden, in 1957. At a special session held on 14th August the *European Association for Potato Research* was formed and the Constitution ratified. DR. EMILSSON was thereupon unanimously elected as first President.

During the working out of the detailed organisation of the proposed Association it became increasingly clear that there was a remarkable measure of agreement between all concerned as to what should be the aims of the Association when formed and how best they might be achieved. The broad aims agreed upon are laid down in Article II of the Constitution. They are: „*to promote the exchange of scientific and general information relating to all phases of the potato industry between the various countries of Europe and to encourage and assist international co-operation in the study of problems of common interest in this field*".

All members of the Interim Council attached great importance to the potential role of the Association in facilitating contact between specialists in different fields and between the specialist and those more directly concerned with the practical and commercial aspects of the crop. Apart from the obvious advantage to those engaged in research of hearing at first-hand of the difficulties and requirements of all sides of the industry throughout Europe, the value of bringing the problems of one specialist group to the notice of another might often be considerable. For example, the solution to some of the problems of the Engineer might lie with the Breeders; to those of the Food Technologist with the Physiologist and so on. Developing the same theme still further, it was suggested that, in future, conference lecture sessions should be concerned not so much with the presentation of the results of individual pieces of original work but rather with the provision of a wide survey of problems and advances in the major fields of research by specialists in the respective subjects. In this way each would get an insight into the other's problems and so be able to advise and to establish fruitful collaboration. It was felt that such a widening of the horizon could not be anything but beneficial to specialists in their own work as well.

The virtually autonomous subject groups within the Association, for which provision has been made in the Constitution, are intended to provide a focus for corporate specialist action in the activities of the Association. They will also provide a facility for the development of international co-operation in fields not already catered for.

Further functions of the Association were envisaged as being the encouragement of international co-operation on particular problems, especially those involving more than one field of research; co-operation with existing international organisations of specialists as far as they deal with the potato crop; the provision of a clearing house for requests for advice and assistance and lastly, the organisation and publication of the *European Potato Journal.*

The instrument has now been provided, the use made of it and its future development rests to a large extent on the efforts of each individual member.

RÉSUMÉ

L'ORIGINE ET LES OBJECTIFS DE L'ASSOCIATION EUROPÉENNE POUR LA RECHERCHE SUR LA POMME DE TERRE

Née d'une série de Conférences inofficielles sur la pomme de terre, tenues á l'échelon international dans différents pays de l'Europe en l'espace 1951–1957, l'Association Européenne pour la Recherche sur la Pomme de terre, á laquelle peuvent adhérer tous les pays, et traitant de l'ensemble des sujets en cette matière, fut inaugurée à Lund en Suède, le 14 août 1957. Les principes sur lesquels s'étaye l'Association, prévus à l'article II de ses Statuts, sont: „*promouvoir l'échange d'informations scientifiques et générales, relatives à toutes les phases de la production de la pomme de terre entre les pays de l'Europe respectifs, de même que stimuler et soutenir la coopération dans l'étude des problèmes d'intérêt mutuel.*"

L'une des principales fonctions de l'Association sera de faciliter la prise de contact entre les spécialistes dans les différents domaines de la recherche scientifique, et entre les experts et tous ceux qui sont mêlés de près aux aspects pratiques et commerciaux de cette culture.

La publication officielle de l'Association sera le „European Potato Journal" (Journal Européen de la Pomme de terre).

ZUSAMMENFASSUNG

URSPRONG UND ZIEL DER „EUROPÄISCHEN GESELLSCHAFT FÜR KARTOFFELFORSCHUNG"

Entstanden aus einer Reihe von internationalen nicht-offiziellen Zusammenkünften in betreff Kartoffeln, die zwischen 1951 und 1957 in verschiedenen europäischen Ländern stattfanden, wurde die „Europäische Gesellschaft für Kartoffelforschung", die für alle Länder offensteht und die sich mit allen einschlägigen Themen befasst, am 14. August 1957 in Lund (Schweden) gegründet. Die grundlegende Zielsetzung dieser Gesellschaft, wie sie in Paragraph II ihrer Satzungen dargelegt wurde, ist: „*den Austausch wissenschaftlicher und allgemeiner Informationen, die Bezug haben auf alle Phasen des Kartoffelbaues, zwischen den einzelnen Ländern in Europa zu fördern und die internationale Zusammenarbeit beim Studium der Probleme von gegenseitigen Interesse anzuregen und zu unterstützen.*"

Eine der Hauptfunktionen der Gesellschaft wird sein, die Beziehungen zwischen den Spezialisten auf verschiedenen Forschungsgebieten zu erleichtern, ebenso wie die zwischen Spezialisten und solchen Personen, die mehr unmittelbar mit den praktischen und kommerziellen Aspekten der Kartoffelkultur zu tun haben. Das offizielle Organ der Gesellschaft wird die „Europäische Kartoffelzeitschrift" sein.

THE FOURTH INTERNATIONAL INFORMAL POTATO CONFERENCE

B. EMILSSON
I.V.K., Nynäshamn, Sweden

The fourth International Informal Potato Conference was held at the Grand Hotel, Lund, Sweden from August 12th to 14th 1957. It was organized by a committee consisting of DR. B. EMILSSON (President), byråchef T. AKESSON and överdirektör A. ÖRBORN. MR. H. NILSSON was secretary of the conference and MR. R. HÅKANSSON served as press commissioner. Financial support for the arrangements was generously given by Kooperativa Förbundet, Svenska Lantmännens Riksförbund and Sveriges Potatisodlares Riksförbund.

The Conference was attended by 122 people from 14 different countries as follows: Austria 1, Denmark 9, Finland 1, France 1, East Germany 2, West Germany 8, Italy 4, Luxemburg 1, The Netherlands 12, Norway 7, Switzerland 2, Spain 1, United Kingdom 10, and Sweden 63.

Most of the participants assembled in Lund on Sunday August 11th. A meeting of the Interim Council of the proposed European Association for Potato Research was also held on that day.

The Swedish Minister of Agriculture, MR. N. G. HANSSON, formally opened the Conference on the morning of August 12th. In his opening speech the Minister, who is himself a practical farmer, showed that he knew a great deal about the problems of potato production. He expressed the hope that the meeting would provide opportunities not only for lectures and technical discussions but also for personal contacts and informal discussion between research workers from the different countries.

The first lecture session started immediately after the opening speeches. In all 21 lectures were given during 4 lecture sessions. The detailed programme is given below.

LECTURE PROGRAMME:

Lecture session 1, August 12th 9.30–12.00 (DR. B. EMILSSON in the chair).

1: a W. RUDORF (Germany): Genreserven in Wildarten für die Resistenzzüchtung der Kartoffel.
1: b A. LUNDEN (Norway): Breeding for resistance (immunity) to wart disease and virus X in potatoes.
1: c B. JACOBSEN (Denmark): The potato breeding programme in Denmark and its results.
1: d J. M. HARRIES (U.K.): The assessment of eating quality of potatoes.
1: e C. LUGT (Holland): Organoleptic quality research.

Lecture session 2, August 12th 13.30–15.30 (DR. R. SALZMANN in the chair)

2: a J. C. HAWKINS (U.K.): Problems in the design of potato harvesters.
2: b D. SIMONS (Germany): Beschädigungen an Kartoffeln durch Erntemaschinen (Read by F. Traphagen).
2: c E. W. BOOGAARD (Holland): Mechanization in potato harvesting and investigations on mechanical damages to potatoes.
2: d H. NILSSON (Sweden): Automatische Temperaturregulierung von Kartoffel-Lagerhäusern.

Lecture session 3, August 13th 8.30–12.00 (DR. P. MADEC in the chair)

3: a A. LETNES (Norway): Potato sprouting affected by soil moisture.
3: b FR. HEICK (Denmark): Bewässerungsversuche in Kartoffeln und Bewässerung gegen Frostschäden.
3: c A. DAM KOFOED (Denmark): Farmyard manure and fertilizers to potatoes.
3: d J. MÜNSTER (Switzerland): Einige technische Probleme der Kartoffelsaatgutproduktion in der Schweiz.
3: e SV. E. HANSEN (Denmark): Diagnosis of the potato leafroll disease.

Lecture session 4, August 13th 13.30–17.30 (DR. H. BRAUN in the chair)

4: a M. M. DE LINT (Holland): Control of late blight with dithiocarbamates.
4: b K. BJÖRLING (Sweden): Biological and technical notes on spraying against potato blight.
4: c E. FÖRSUND (Norway): The connection between the climate and outbreak of late blight epiphytotics. Late blight warning service by means of 3-days weather forecasts.
4: d J. H. VAN EMDEN & R. E. LABRUYÈRE (Holland): Some results of experiments on the control of common scab of potatoes by means of chemical treatment of the soil.
4: e N. GUSTAFSSON (Sweden): Control of common scab by pentachloronitrobenzene.
4: f W. G. BURTON (U.K.): Work at the Ditton laboratory on the sprouting of potatoes.
4: g O. FISCHNICH (Germany): Maleinsäurehydrazid (MH) und seine Auswirkung auf die wachsende und lagernde Kartoffelknolle. Wachstumsregulatoren im Kartoffelbau zur Unkrautbekämpfung.

Arrangements had been made for simultaneous translation of all proceedings into English, German and French. With few exceptions papers were followed by informative and interesting discussions, almost as much time having been allowed in the programme for this as for the actual lectures.

The second lecture session on Monday August 12th was followed by a demonstration session in the late afternoon. The members were brought by buses to the experimental farm at Habo, belonging to the State Research Institute for Farm Buildings. MR. A. ÖRBORN demonstrated an experimental potato storage house of novel and very inexpensive design. This was followed by an exhibition of potato machinery – the largest one ever held in Sweden – which had been arranged on the farm by MR. S. ANDERSSON, specialist in agricultural engineering of the County Agricultural Society of Malmö. Fifty two machines were on view including planters, harvesters, graders, spraying machines etc. A catalogue in English, French and German was distributed giving detailed information on the various machines.

On Tuesday evening a visit was arranged to the premises of a big wholesale dealer in potatoes at Malmö. Here equipment for packing potatoes into consumer size bags was demonstrated.

Although the official programme for the Conference as outlined above was quite crowded, everyone also found time for friendly intercourse and personal discussions. The Swedish Ministry of Agriculture invited all members of the Conference to luncheon on the opening day, with the Minister acting as host. A conference banquet, given by the city of Lund, was held on the Tuesday night. The guests were welcomed by MR. T. ANDRE, chairman of the City Council of Lund.

The morning of Wednesday August 14th was devoted to the inaugural session of the European Association for Potato Research. Immediately afterwards the newly appointed Council of the Association held a short session. Minutes of both meetings are to be found on p. 8 and 9 in this issue.

A field excursion, in which most of the foreign members of the Conference took part, started from Lund on Wednesday at 14.00 p.m. The excursion was organized and conducted by MR. C. BJÖRKLUND of the County Agriculture Society of Kristianstad. The first stop was at Hässleholm, where a large potato storage house and grading centre was visited. Various field experiments on potatoes were studied at Vanneberga Experimental Farm. Dinner was arranged at the famous old castle and monastery at Bärkaskog, where everyone also enjoyed a stroll in the magnificent park.

An early start was made next morning with visits to the State Experimental Farm of Ugerup near Kristianstad and the substation of the Swedish Seed Association also at Ugerup. At the Experimental Farm MR. B. RÄTTZÉN demonstrated field experiments on potatoes, while DR. O. TEDIN and Dr. T. DENWARD showed potato breeding work at the Svalöv station.

The next stop was at the big estate of Wittskövle. A newly erected potato storage house of large capacity and original design attracted much attention and the architect had to answer a lot of questions. In the meantime the proprietor, Count P. DE LA GARDIE took the ladies for a walk through his magnificent gardens. The journey went on through some of the most beautiful parts of Scänia to the old city of Simrishamn on the Baltic sea. Here luncheon was served, featuring different dishes of eel, a speciality of Simrishamn.

During the afternoon visits were paid to the old mediaeval castle of Glimmingehus, to the seed firm of Messrs. Otto J. Olson & Son at Hammenhög, where a modern storage house for potatoes and flower bulbs was studied, to the School of Agriculture at Tomelilla for demonstrations of potato field experiments and finally to the Benestad farm at Benestad, to see a modern farm storage house for potatoes.

The party returned to Lund on Thursday evening and a farewell dinner was held at the Grand Hotel. At this dinner DR. B. EMILSSON handed over the office of President of the European Association for Potato Research to Prof. DR. O. FISCHNICH, who thereupon extended to everybody present a most hearty welcome to the next potato conference, the first one of the E.A.P.R., to be held at Völkenrode near Brunswick in West Germany, in 1960.

EUROPEAN ASSOCIATION FOR POTATO RESEARCH

INAUGURAL GENERAL MEETING

The Inaugural General Meeting of the Association was held at the Grand Hotell, Lund, Sweden, on Wednesday 14th August 1957.
The following were present:

Dr. B. Emilsson (*in the chair*) Prof. Dr. O. Fischnich Forst. F. Hansen Dr. W. H. de Jong Dr. A. R. Wilson H. Nilsson – Acting Secretary	Members of the Interim Council

Members of the 4th International Informal Conference on Potatoes.

1 Formation of the association

The formation of the Association was formally approved. Dr. A. R. Wilson (U.K.) then moved that Dr. B. Emilsson (Sweden) be elected first President of the Association to serve until the end of the 4th International Informal Potato Conference. This motion was seconded and carried unanimously.

2 Constitution of the association

The draft Constitution of the Association was discussed and, after amendment, ratified.

3 Election of officers and council

The chairman submitted the following nominations for 1957–60 from the Interim Council:

President:	Prof. Dr. O. Fischnich (Germany)
Vice-President:	Dr. A. R. Wilson (U.K.)
Councillors:	B. Jacobsen Mag. agro (Denmark)
	Dir. P. Madec (France)
	Dr. R. Salzmann (Switzerland)

The above were unanimously elected.

4 Place and date of next conference

The chairman announced that the Interim Council had decided that the First Conference of the Association would be held at Brunswick-Völkenrode, Germany in 1960. Details and precise dates to be circulated nearer the time.

5 Any other business

The chairman requested and the Meeting agreed that power be delegated on this occasion to the Council to appoint a Chartered Accountant in accordance with Article XVI, Section 2 of the Constitution.
The meeting was then closed.

FIRST COUNCIL MEETING

A meeting of the Council was held at the Grand Hotell, Lund, Sweden, on Wednesday 14th August 1957.
The following were present:

DR. B. EMILSSON (*in the chair*)
PROF. DR. O. FISCHNICH
FORST. B. JACOBSEN
DR. W. H. DE JONG (*item 2 only*)
DIR. P. MADEC
DR. R. SALZMANN
DR. A. R. WILSON
DR. D. E. VAN DER ZAAG (*item 2 only*)

1 Appointments

The following appointments were made under Article X, Section 2 and Article XIV, Section 2 of the Constitution:

Secretary of the Association:	DR. D. E. VAN DER ZAAG (the Netherlands)
Treasurer of the Association:	DR. W. H. DE JONG (the Netherlands)
Editor of the European Potato Journal:	DR. W. H. DE JONG (the Netherlands)

DR. VAN DER ZAAG and DR. DE JONG were then welcomed as members of the Council.

2 Date of next meeting

It was decided to hold the next Council Meeting in January or February 1958, the exact date and time to be decided later by the President.
The meeting was then closed.

Signed: O. FISCHNICH

THE SIGNIFICANCE OF WILD SPECIES FOR POTATO BREEDING[1])

W. RUDORF
Direktor des Max-Planck-Institutes für Züchtungsforschung, Köln-Vogelsang
Summery in Eng., G. & Fr., p. 19.

The significance of wild species of the potato has been recognized to its full extent only when forms of them had been collected and classified in systematical order and the economic importance of selecting resistant varieties had become a problem of first order. The impulse was given by *Phytophthora infestans*, and *Solanum demissum*, by chance existing in Europe at that time, was used at first. For about thirty years collections have been completed and a more systematic use of wild species could be made. Phytopathological, cytogenetical and genetic researches as well as the experiences of selection work have now created a stable basis and improving results. In this conference I shall refer chiefly to experiences achieved in our institute.

SELECTION OF RESISTANT VARIETIES

Resistance to Phytophthora infestans

It is known that in selecting varieties resistant to late blight (*Phytophthora infestans*) hypersensitivity has constituted the basis and that dominant major genes effectuate this type of resistance, which has been overcome again and again by new races of the fungus. We have endeavoured to protect ourselves against this danger by building up hybrids by means of different wild species, i.e. lines of them, which were resistant to all races known at the time. From 1948 to 1950 nevertheless most of these hybrids broke down, and consequently we have concentrated all our attention on those hybrids which demonstrated „field resistance" (10, 11).

We have observed that this type of resistance which manifests itself in a deminished fructification after a prolonged incubation period reduces the damage much. This resistance which may also be called „incubation resistance" rests on a polygenic basis and is inherited as a dominant quantitative character.

The oldest of the field resistant hybrid clones, which possess the characteristics of cultivated varieties, are seedlings of the years 1943–1944. The results of testing some of them in Mexico (7) coincide pretty well with observations made at several places in Northwest Germany (see table 1 and fig. 1).

For a long time it has been recognized that strains of hybrids, which demonstrate foliage resistance, do not necessarily possess tuber resistance as well. Consequently

[1] Lecture held at Lund, August 1957.

TABLE 1. Fieldresistance of some clones of the Max-Planck-Institute, tested in Mexico (Toluca-Valley) and at Scharnhorst and Weidefeld in Northwest Germany

No. of clone *No. der Klone*	Descent *Abstammung*	Toluca Valley *Toluca-Tal*			MPI Scharnhorst *MPI Scharnhorst*			MPI Weidefeld *MPI Weidefeld*			Remarks *Bemerkungen*
		1954	1955[2]	1956[3]	1954	1955	1956	1954	1955	1956	
43.808/34	DT^4	2	1+2	2	0	0	0	2	0–1	0	
43.821/18	$DT^1 \times DT^8$			3	0	0		5	1–2		[4]
44.685/1	A × s		1	1	0	0	0	3	1	1–2	
49.504/20	$DT^1 \times DT^4$	3	1+2	2	0	0	0	3	0–1	0–1	
49.515/1	$DT^1 \times (DT^x \times DT^8)$			3	0	0		3–4	2–3		
49.536/13	DT^1			4	0–1	0		0	0		
49.622/3	$DT^2 \times DT^x$		3	3	0	0		3	0–1		
49.642/5	$DT^1 \times DT^3$		2	2	0	0	0	1–2	0	0–1	
49.694/2	$DT^1 \times DT^8$		1	3	0	0–1	1–2	3–4	1–2	1–2	
49.767/7	$[(S. \times DT^8) \times DT^8] \times DT^8$			4	0	0		1–2	0–1		[5]
50.296/7	$DT^1 \times AT^3$		1–2	2	0	0–1		3	0		[4]
51.1389/1	$(A \times s) \times (DT^8 \times AT^2)$		2	3	0	0		1–2	2		
52.201/18	$(DT^1 \times DT^8) \times [(DT^1 \times DT^8) \times T]$			3		0–1			1–2		
52.234/56	$(A \times s) \times (DT^3 \times AT^2)$			4		0			0		
52.275/32	$(A \times s) \times (DT^3 \times AT^2)$			4		0			0		
52.420/3	$(DT^1 \times DT^8) \times [(P\ T) \times s]$			3	0	0			1–2		
52.504/2	$[(P\ T \times DT^8) \times s] \times (A \times s)$			2		2			2		
52.504/4	$[(P\ T \times DT^8) \times s] \times (A \times s)$		2	2			0			1–2	[4]

TABELLE 1. *Feldresistenz einiger Klone des Max-Planck-Instituts, untersucht in Mexiko (Toluca-Tal) und in Scharnhorst und Weidefeld (Nordwestdeutschland)*

[2] 1955: 3281 U.S.A. seedlings were classified as follows: Grade 1 = 0 seedlings, 2 = 1 seedling, 3 = 185 seedlings, 5 = 3095 seedlings.

[3] 1956: Three weeks earlier to these observations test plants with the alleles $R_1R_2R_3R_4$ had shown susceptibility.
The variety Alpha was completely destroyed 2 weeks earlier.

[4] Resistent to all known races of wart.

[5] Immune to Y and A.

Grades: 0 = without infection, 5 = heaviest infection
D for *S. demissum*, T for *S. tuberosum*, S for *S. stoloniferum*, A for *S. andigena*, P for *S. polyadenium*.
Index indicates number of backcrosses inclusive first cross.

[2] *1955: 3281 Klone aus den Ver. Staaten, wie folgt klassifiziert: Klasse 1 = 0 Klon, 2 = 1 Klon, 3 = 185 Klone, 5 = 3095 Klone.*

[3] *1956: 3 wochen vor der Durchführung obiger Bonituren zeigten die Klone mit den Allelen $R_1R_2R_3R_4$ Anfälligkeit.*
Die Sorte Alpha war nach zwei Wochen völlig zerstört.

[4] *Widerstandsfähig gegen alle neue Biotypen der Kartoffelkrebses.*

[5] *Unempfänglich für Y und A.*

Klassen: 0 = ohne Infektion, 5 = schwerste Infektion. D für S. demissum, T für S. tuberosum, S für S. stoloniferum, A für S. andigena, P für S. polyadenium.
Der Index gibt die Zahl der Rückkreuzungen an einschliesslich der ersten Kreuzungan.

we must select simultaneously for foliage and tuber resistance. Rather a large number of our hybrids corresponds to this demand. The infection method of the tubers, however, must be developed to a greater perfection. Besides, the differentiation of hypersensitivity and incubation resistance by means of different „passages" of the infect on the infected strain is of great importance (Fig. 2).

Resistance to Alternaria solani

We have not realized extensive researches regarding the resistance to *Alternaria solani*, but we have frequently observed a pronounced susceptibility in hybrids of *S. demissum*. Nevertheless we have succeeded in selecting hybrids of *S. demissum* which demonstrate a sufficient resistance due to the descent from certain varieties of *S. tuberosum*. In this case too tuber resistance is of great importance. Wild species have not been submitted to a systematic testing by us, but according to literary notes (3, 4) *S. chacoense*, *S. toralapanum*, *S. tarijense* and possibly *S. bulbocastanum* show resistance.

Resistance to Rhizoctonia solani

As regards *Rhizoctonia solani*, the testing of wild species made it clear that only *S. suaveolens* demonstrates resistance (5). But this species is of such a remote parentage that it does not cross with *S. tuberosum*.

FIG. 1. RESISTANCE OF MPI SEEDLINGS IN TOLUCA VALLEY COMPARED WITH SEEDLINGS OF OTHER PROVENIENCES, WHICH ARE HEAVILY INFECTED. (Photo DR. NIEDERHAUSER, 1955)

FIG. 1. *Resistenz von MPI-Saatkartoffeln im Toluca-Tal, verglichen mit Saatkartoffeln anderer Herkunft, die stark infiziert sind.* (*Lichtbild* DR. NIEDERHAUSER, 1955)

Resistance to Streptomyces scabies

As resistance to *Streptomyces scabies* can be found in varieties of *S. tuberosum* (Bismarck, Jubel and others), we have not effectuated a systematic test of wild species. But we were able to confirm that some species of *Commersoniana*, especially *S. chacoense*, inherit good resistance. Tests are carried out in a naturally infected field near Ebstorf (Lüneburger Heide) and we may presume that there is a genetic disposition for resistance within some of our hybrids, built up with other species.

Resistance to Spongospora subterranea

Resistance to *Spongospora subterranea* has not been the object of systematic researches.

Resistance to Synchytrium endobioticum

As new races of *Synchytrium endobioticum* have appeared we have been engaged to test our hybrids for their resistance to them. These researches are carried out in infected fields in some mountainous regions of Western Germany as well as in laboratories by ourselves and the Biologische Bundesanstalt. Very reliable results have been obtained by testing in infected fields and we have been able to prove that a

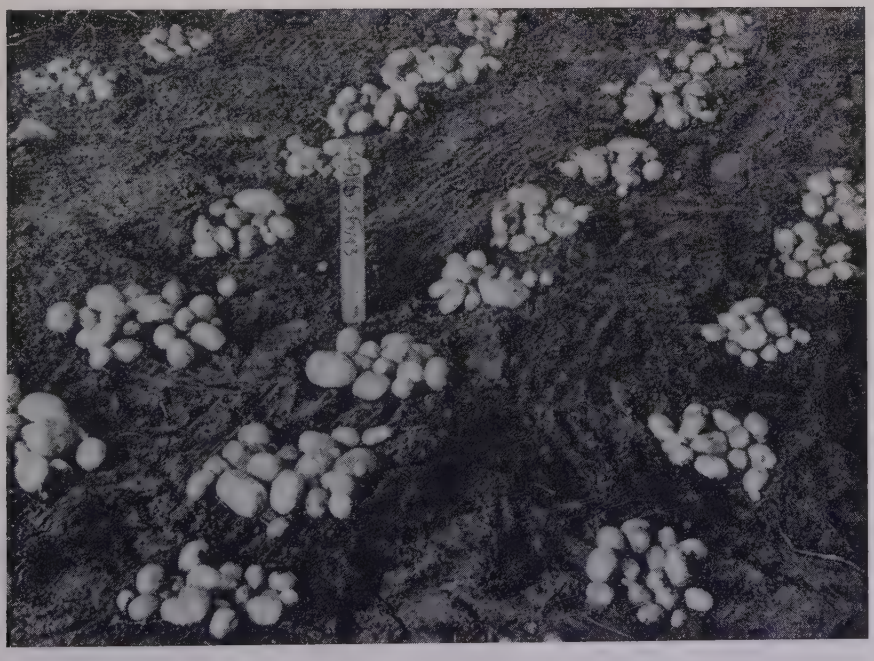


FIG. 2. AN EARLY LATE BLIGHT RESISTANT SEEDLING
FIG. 2. *Saatknollen einer gegen Kraut- und Knollenfäule (Phytophthora infestans) widerstandsfähigen Frühkartoffel*

pretty large number of hybrids is resistant to one race or the other, whereas the combined resistance to all known races is restricted to a few hybrids only. Some of the latter have been delivered to private breeders. They have been obtained by hybridization with *S. demissum*, *S. acaule*, *S. andigena*, and *S. polyadenium* (see table 1).

Resistance to virus diseases

The heaviest damages in the production of potatoes are caused by virus diseases. There is no longer any discussion about direct ecological degeneration or that by age. It is known that different virus diseases cause what we call „Abbau" (degeneration). For twenty years we have directed all attention on the selection of virus resistant varieties. The first success was the observation made by STELZNER (12) that certain lines of *S. acaule* possess resistance to virus X and that others of *S. stoloniferum* manifest resistance to virus Y. These results have been confirmed and the genetic basis has been analysed by ROSS (8). According to the latest results of these researches we can discern three standard reactions namely: susceptibility, hypersensitivity and extreme resistance (immunity).
The factorial analysis indicates that with good prohability unilocal alleles Ry, ryn and ry determine the three standard reactions and that there exists a dominance of Ry over ryn and of ryn over ry. Segregation follows the disomic scheme 3:1.
We prefer extreme resistance (Ry), the more as it refers to all strains of virus Y and also to the veinal strain, which in recent times constitutes a heavy danger for some of our most cultivated renowned varieties.
In certain lines of *S. acaule* standard reactions for the resistance to virus X have been found which correspond with those found in *S. stoloniferum* for virus Y. The allele Rx determines extreme resistance to all strains of X. As the genetics of resistance to the mosaic viruses are very simple it has been possible to transfer the resistance to hybrids with variety characteristics. We have even succeeded in selecting clones which possess the combined extreme resistance to the three mosaic viruses. The production of first generation hybrids of *S. stoloniferum* or *S. acaule*, however, meets with some difficulties (Fig. 3).

Quite a different situation arises regarding leaf roll virus. Intensive investigations of wild species did not lead to the discovery of the standard reactions known with the mosaic viruses. However, great differences in the rapidity and the grade of infection have been observed with hybrids descendent from different wild species. Researches effectuated by Miss BAERECKE (1, 2) have demonstrated that the resistance of these hybrids may be defined as a resistance to infection. By means of infection with infectious aphids and by experiments in regions with a sufficient frequency of natural infection (Abbauversuche) one is able to test this „infection resistance". There are highly significant differences in the grade of infection resistance and at the same time there can be observed a clear variation concerning hypersensitivity and tolerance.

FIG. 3. A SEEDLING BUILT UP WITH SPECIES *S. stoloniferum*, *S. acaule* AND *S. tuberosum* WHICH MANIFESTS IMMUNITY TO THE THREE MOSAIC VIRUSES

FIG. 3. *Ein aus den Spezies S. stoloniferum, S. acaule und S. tuberosum aufgebauter Sämling, der Immunität gegen die drei Mosaik-Viren zeigt*

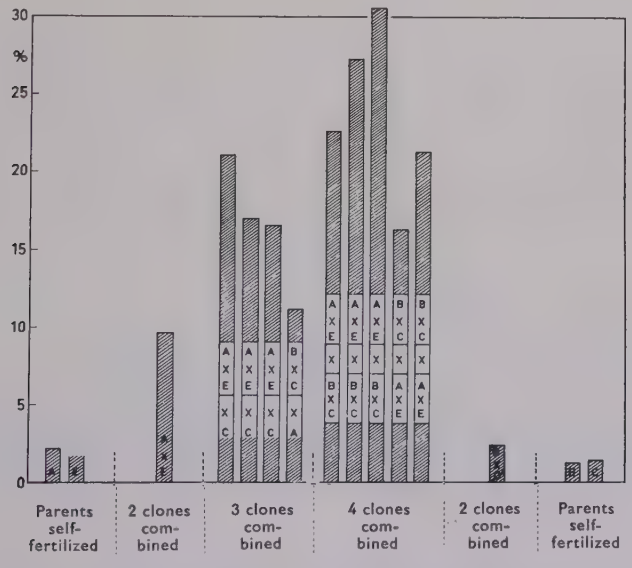


FIG. 4. PERCENTAGE OF LEAFROLL RESISTANT SEEDLINGS WHICH HAVE BEEN TWICE INFECTED ARTIFICIALLY. CLONES A, B, C, E, THE RELATIVELY LEAFROLL RESISTANT PARENTS

FIG. 4. *Prozentsatz blattrollresistenter Klone nach zweimaliger künstlicher Infektion. Vergleich der Selbstungnachkommenschaften von 4 Ausgangsklonen A, B, C, E.*

The infection resistance rests on a polygenic basis. Even some varieties of *S. tuberosum* and, even more hybrids of *S. andigena*, *S. acaule*, *S. demissum*, and *S. edinense* contain alleles of resistance. The crossing of such varieties and more so of the above mentioned hybrids leads to an accumulation of alleles for resistance, which produces an augmented resistance. The improvement of infection resistance to leaf roll is obtained according to the scheme of maize hybrids and one might speak of a heterosis of infection resistance (Fig. 4 and 5).

FIG. 5. IN THE FOREGROUND THE VARIETY SHAMROCK, BEHIND CLONE 44.335/130 AFTER TWO YEARS NATURAL INFECTION WITH LEAFROLL

FIG. 5. *Im Vordergrund die Sorte „Shamrock", dahinter Klon* 44.335/130 *nach zwei Jahren natürlicher Infektion mit Blattroll-Virus*

Resistance to Heterodera rostochiensis and Leptinotarsa decemlineata (potato beetle)
It is known that in lines of *S. andigena*, *S. polyadenium*, and *S. vernei* there are genes for resistance to *Heterodera rostochiensis* (6, 14), which are being used in breeding work with good results. On the other side the breeding for resistance to the potato beetle by hybridization with *S. chacoense* and *S. demissum* has been proved to be very complicated (13).

OTHER OBJECTS OF SELECTION

Finally I might remark that the combination of all factors of resistance is the final aim of our researches and that to obtain this success the methods of inbreeding and out-

breeding (heterosis) are largely applied. It is selfevident that the different characteristics of resistance cannot by the only object of selection. On the contrary they must be obtained simultaneously with the improvement of yield, quality, characteristics of tubers, high starch content etc. With reference to quality and taste, hybrids of *S. stoloniferum* and *S. chacoense* claim special attention. Besides the method of repeated backcrosses offers the opportunity to select any type of variety (9).

Nevertheless, some difficulties in hybridization of *S. tuberosum* should be mentioned. There are some surprising facts. Diploid species, such as *S. verrucosum* and *S. chacoense*, cross easily, *S. polyadenium* however much less easily with *S. tuberosum* and often tetraploid hybrids are produced due to the formation of diploid eggcells. Curiously enough, the tetraploid species *S. acaule* and *S. stoloniferum* do not cross easily with the tetraploid *S. tuberosum* and hybrids are produced on these species too by means of unreduced female gametes. Investigations of VON WANGENHEIM (15) and others have shown that the embryos of 4 n *S. stoloniferum* and *S. acaule* × 4 n *S. tuberosum* hybrids die on account of degeneration of the endosperm, whereas 8 n

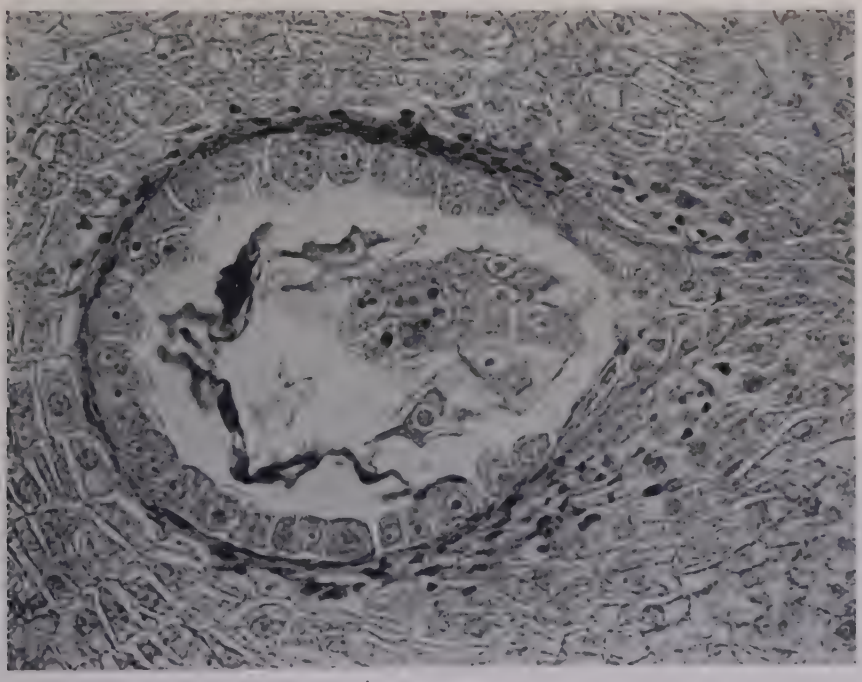


FIG. 6. S. ACAULE 4n × S. TUBEROSUM 4n.
Embryological development 7 days after pollination. Endosperm degenerated, embryo still normal, will die soon

FIG. 6. *S. acaule* 4n × *S. tuberosum* 4n.
Embryonale Entwicklung 7 Tage nach der Bestäubung. Endosperm degeneriert, Embryo noch normal, stirbt bald ab.

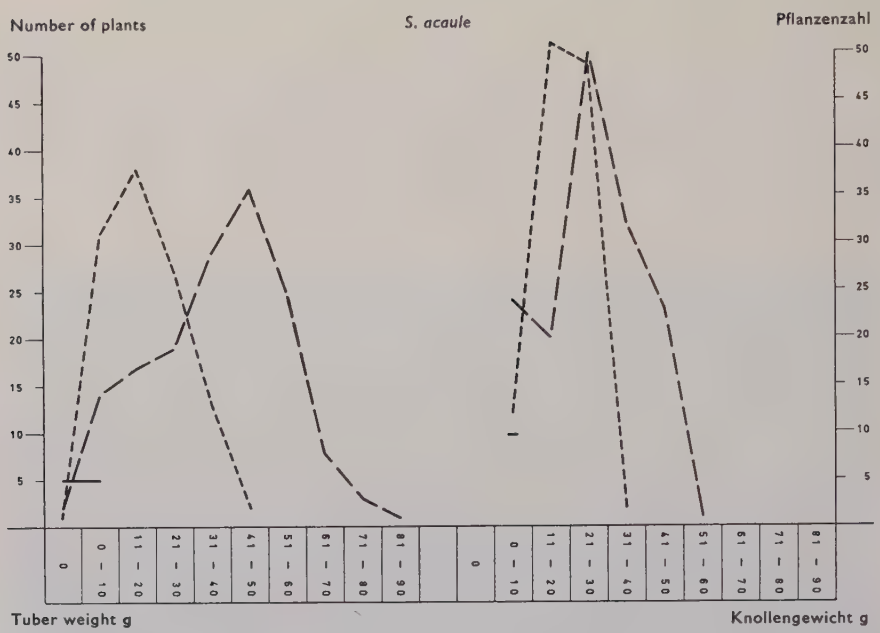


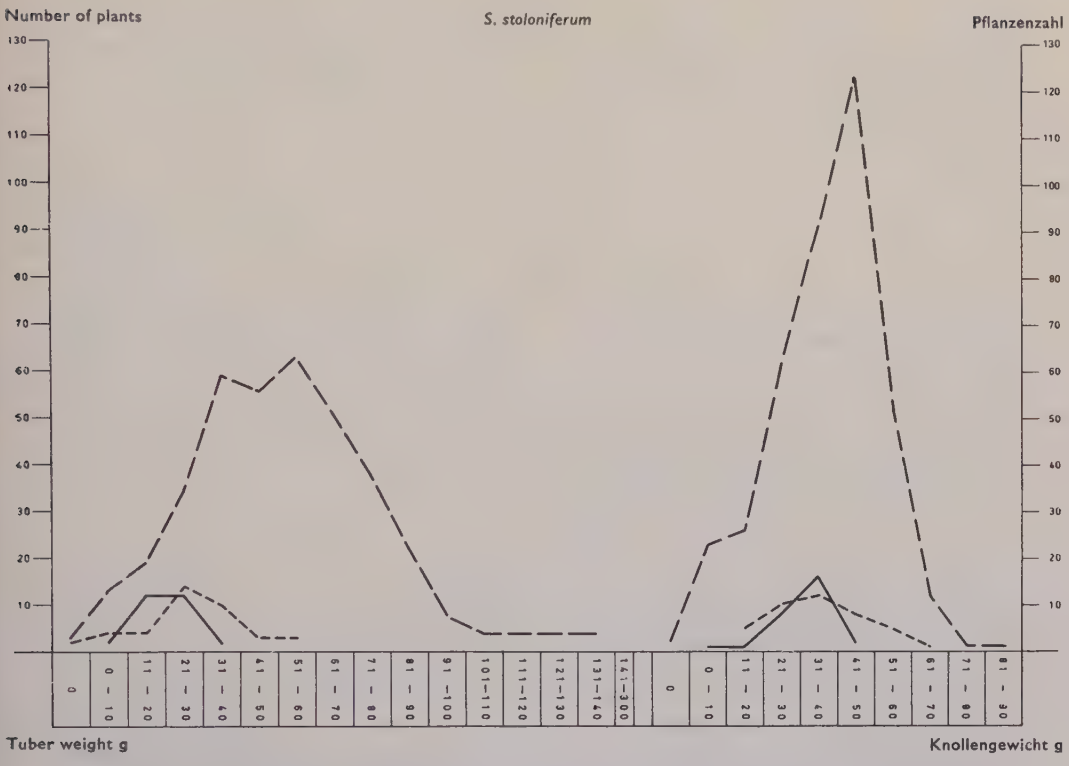
FIG. 7. TUBER WEIGHT OF *S. acaule* (PAGE 18) AND *S. stoloniferum* (PAGE 19). 1. GENERATIONS OF THE CROSS WITH *S. tuberosum* AND OF 1. BACKCROSS UNDER LONG DAY – (AT LEFT) AND SHORT DAY – (AT RIGHT) CONDITIONS. LONG DAY CA 16–17 HOURS, SHORT DAY 10 HOURS.

FIG. 7. *Knollengewicht von S. acaule (S. 18) und S. stoloniferum (S. 19). 1. Generation der Kreuzung mit S. tuberosum und der 1. Rückkreuzung unter Langtag – (links) und Kurztag – (rechts) Bedingungen. Langtag ca 16–17 Stunden, Kurztag 10 Stunden.*

Page 18, *Seite 18*	Page 19, *Seite 19*	
——— *Sol. acaule*; n = 10 L. n = 10 K.	*Sol. Stoloniferum*; n = 28 L. n = 21 K	———
— — (*Sol. ac.* × Fichtelgold) × 49.540; n = 154 L, n = 150 K	(*Sol. Stol.* × Fichtelgold) × n = 44.1016; n = 396 L, 394 K	— —
- - - - - (*Sol. ac.* × Fichlelgold) $_{\text{self-fertilized}}$ n = 112 L; n = 114 K	(*Sol. Stol.* × Fichtelgold) $_{\text{naturally self-fertilized}}$ n = 40 L, 41 K	- - - - -

S. stoloniferum and *S. acaule* × 4 n *S. tuberosum* permit a pretty normal development of endosperm and embryo. After various backcrosses with *S. tuberosum*, even strains with good yields, prove to be aneuploid. They produce few and bad pollen grains, but can be easily crossed with *S. tuberosum*, when used as female partners. Our experiences have proved that these difficulties can be overcome in breeding programs in the same way as the elimination of surplus chromosomes in hybrids with *S. demissum*.

Quite another problem is the photoperiodic reaction of the wild species, which is a very pronounced short-day reaction for tuber production and a long-day reaction for flowering. Principally, varieties of *S. tuberosum* show the same photoperiodic reaction, but in a less pronounced grade with reference to tuber formation. Our investigations have proved that after the first backcross already a remarkable shift to the behaviour of *S. tuberosum* varieties has taken place. These observations prove that



lateness and luxurious development of stem and foliage in hybrids of younger generations are to a great deal the consequence of short-day reaction. These difficulties are easily overcome after three to four backcrosses. Formation of unwanted stolones obeys to the same photoperiodic reaction (Fig. 7).

SUMMARY

THE IMPORTANCE OF WILD POTATO SPECIES IN BREEDING

The writer discusses the selection work performed at the Max-Planck-Institute at Cologne-Vogelsang.

Attention was particularly concentrated on finding crosses with wild species resistant to diseases and plagues. The writer discusses in turn the results obtained with resistance to *Phytophthora infestans*, *Alternaria solani*, *Rhizoctonia solani*, *Streptomyces scabies*, *Spongospora subterranea*, *Synchytrium endobioticum*, virus diseases, *Heterodera rostochiensis* and Colorado beetle.

He also refers to various difficulties that occur in crosses with wild species.

ZUSAMMENFASSUNG

DIE BEDEUTUNG VON KARTOFFELWILDARTEN FÜR DIE KARTOFFELZÜCHTUNG

Der Verfasser bespricht die Selektionsarbeit, die im Max-Planck-Institut in Köln-Vogelsang verrichtet worden ist.

Die Aufmerksamkeit war vor allem darauf konzentriert, Kreuzungen mit Wildarten zu suchen, die resistent sind gegen Krankheiten und Schäd-

lingsplagen. Nacheinander bespricht der Verfasser die Ergebnisse, die erreicht worden sind mit der Resistenz gegen *Phytophthora infestans*, *Alternaria solani*, *Rhizoctonia solani*, *Streptomyces scabies*, *Spongospora subterranea*, *Synchytrium endobioticum*, Viruskrankheiten, *Heterodera rostochiensis* und Kartoffelkäfer.
Ferner nennt er einige Schwierigkeiten, die bei Kreuzungen mit Wildarten entstehen.

RÉSUMÉ

L'IMPORTANCE DE VARIÉTÉS DE POMMES DE TERRE SAUVAGES EN REGARD DE L'AMÉLIORATION DE L'ESPÈCE

L'auteur donne un exposé sur l'oeuvre sélectionnaire, entreprise à l'Institut-Max-Planck à Cologne-Vogelsang.
Une attention particulière a été apportée notamment à la recherche de croisements avec des éspèces sauvages résistant aux maladies et aux pestes. L'auteur traite ensuite des résultats que donne la résistance à *Phytophthora infestans*, *Alternaria solani*, *Rhizoctonia solani*, *Streptomyces scabies*, *Spongospora subterranea*, *Synchytrium endobioticum*, maladies virologiques, *Heterodera rostochiensis* et au doryphore.
Pour conclure, il traite de quelques difficultés que soulèvent les croisements avec des variétés sauvages.

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THE POTATO BREEDING PROGRAMME IN DENMARK [1]

BØRGE JACOBSEN
Director of the Potato Breeding Station at Vandel, Denmark

Summary in Eng., G. & Fr., p. 23

THE STATE RESEARCH STATION AT TYLSTRUP IN NORTH JUTLAND AND THE POTATO FUND'S BREEDING STATION AT VANDEL

The potato breeding in Denmark is not of recent date, as it has been carried out for more than 35 years, but the extent of the work was rather limited in the years until 1948. Best known was the work of breeding done by the State Research Station at Tylstrup and at the experimental farm „Frederikshøj" belonging to the firm „Danish Distilleries Ltd".

However from the year 1948, the work with potato breeding in Denmark has been much increased, due to the fact that this year, at the request of the Danish agricultural organisations, a fund, Danish Agriculture's Potato Fund, was established. The assets placed at disposal for this fund derived from the profit of former years potato export, and the object of the fund was, first and foremost, to promote the work of potato breeding in Denmark.

The income of the fund is due to interest on a capital of a little more than two million danish Kroner, and furthermore, according to order issued by the Ministry of Agriculture, a small amount of 10 Øre per 100 kilos is levied on all seed potatoes exported or sold on the home market, which are approved and sealed by the Government Plant Inspection Service, who also has to collect the money.

The breeding carried out by the Danish Agriculture's Potato Fund started in the spring of 1950 on a farm owned by the fund in the north-western part of the peninsula of Jutland, but in 1954 it was removed to a quite new-established institute situated at the village of Vandel by Vejle near the main potato growing areas of Central Jutland. The soil is suitable for experimental work, which has been confirmed by the last years' trial cultivation, and the work of potato breeding is now making good progress. Together with the State Research Station at Tylstrup in North Jutland the Potato Fund's breeding station at Vandel are now the only places in Denmark where potato breeding is carried out.

BREEDING FOR CONSUMPTION AND FOR FEEDING AND INDUSTRIAL PURPOSES

Breeding of potatoes for consumption constitutes the greatest part of the work, but also breeding of varieties for feeding and industrial purpose is an important link of

[1] Lecture held at Lund, August 1957

the work, because, in Denmark, such varieties are very much used as fodder for the cattle and pigs. About the half of the whole potato production is used as fodder. The line which is followed is first and foremost find varieties which, as regards yielding capacity and quality, can satisfy the demand from buyer as well as grower. It is my opinion that, to some degree, these factors are being underestimated by many breeders, who, being eager to produce varieties with a special property, f. inst. resistance to one or more diseases, forget to pay sufficient attention to the quality, what will often again bring about that consumers are too little interested in such a variety, no matter what the other good properties are. However, the various potato diseases are playing such an important part in the actual potato growing that it is not sufficient exclusively to take yielding capacity and quality into consideration, but it is necessary to try to combine these properties with resistance to some of the potato diseases which are doing most harm in the district or country in question.

RESISTANCE TO LATE BLIGHT

Late blight (*Phytophtora infestans*) is still considered as one of the most serious potato diseases in Denmark and, consequently, a great work has been and is still being done to find varieties with some degree of resistance. However, the presence of several races of blight has hitherto given trouble.

In Denmark early potato varieties are almost never attacked seriously by late blight, due to the fact that, normally, the blight does not appear until the middle of July, and for this reason we have hitherto not spent much time breeding blight-resistant early varieties, but have paid more attention to the late varieties, where the decrease in yield by violent attacks of late blight can be considerable. Here we are most working with incubation-resistance, which probably does not give immune varieties, but still gives varieties which are attacked to such a small extent that the decrease in yield under Danish conditions is very small.

RESISTANCE TO COMMON SCAB

On certain soils in Denmark the common scab (*Streptomyces scabies*) may be a serious obstacle for the potato production, specially potatoes for consumption or export. The Breeding Station in Vandel therefore now considers it as the chief object of their activities to find varieties with some degree of resistance to common scab. For the time being, all selection of scab resistant material is made on basis of field testings, but examinations are made for improvement of methods of artificial infection.

PRODUCTION OF VIRUS-FREE SEED-POTATOES

The virus diseases of the potato do not plays the part in Denmark as in many other countries, as there are many districts where aphids, and especially *Myzus persicae*, only appear in a very small number. This has been shown in some investigations carried out in the years 1949–54 at the request of the National Control of Potato Propagation where 75 samples out of 195 healthy samples of the variety Bintje in 1949 still in 1954 were nearly healthy. The percentage of leafroll and virus Y had increased

only from 0 to 1.0. The samples has been distributed evenly all over the country, but most of the healthy samples in 1954 was found in the main potato growing areas in Jutland.

As the conditions for production of virus-free seed potatoes, do not need being any great problem in Denmark, we have no hitherto in the breeding programme paid special attention to the question of finding virus-resistant varieties, exceeding that, of course, we have always removed the material that, in the trials, has proved to be very susceptible. However it shall be mentioned that, during the later years, we have been working on producing X-resistant varieties.

The station in Vandel is in possession of a collection of wild and cultivated species of potatoes. Most of this material is brought home from south american countries by the former collaborator of the station, J. P. HJERTING, who stayed over there from 1947 till 1955 and since took part in a botanical expedition to the same countries in the winter of 1955–56.

Now 7 years after commencement of the real breeding programme under Danish Agriculture's Potato Fund, about 25 new varieties have been in trials for 2 years or more, and 3 of the most promising varieties will be sent for official test from 1958.

SUMMARY

THE POTATO BREEDING PROGRAMME IN DENMARK

From 1948 onward there has been a marked increase in potato breeding work in Denmark. This is due to the fact that the Danish Agriculture Potato Fund was established in this year and its proceeds are devoted to the advancement of potato breeding in Denmark. The fund owns the Potato Breeding Station at Vandel, near Vejle, and this together with the State Research Station at Tylstrup are the only places in Denmark where potato breeding is carried out.

Breeding of ware varieties constitutes a great part of the work, although the breeding of varieties used for fodder and industrial purposes is also an important aspect of the work.

The quality and yield capacity of the new varieties are very important considerations, although the present work of breeding also aims at finding varieties which are only slightly affected by late blight and common scab.

As the conditions governing the production of virus-free seed potatoes, do not constitute any serious problem in Denmark, little attention has been paid to the finding of virus-resistant varieties, except on the case of special varieties intended for export.

The station in Vandel owns a fairly large collection of wild and cultivated species of potatoes.

Three of the most promising varieties from Vandel will be sent for an official test as from 1958.

ZUSAMMENFASSUNG

DAS ZÜCHTUNGSPROGRAMM FÜR KARTOFFELBAU IN DÄNEMARK

Seit dem Jahre 1948 ist die Arbeit der Kartoffelzüchtung in Dänemark ganz bedeutend erweitert worden, da in diesem Jahre der „Kartoffelfonds der Landwirtschaft" gegründet wurde, dessen Ertrag in erster Linie die Kartoffelzüchtung Dänemarks stützen soll. Der Fonds besitzt die Zuchtstation bei Vandel. Zusammen mit der Versuchsstation in Tylstrip im Besitz des Staates, ist es die einzigen Stelle in Dänemark, wo Kartoffelzüchtung betrieben wird.

Die Züchtung von Speisekartoffeln ist sehr wichtig, aber auch die Arbeit mit Futter- und Fabrikkartoffeln ist von grösster Bedeutung.

Eigenschaften, wie Ertrag und Qualität der neuen Kartoffelsorten, sind von besonderer Wichtigkeit, aber eines der Ziele der jetzigen

Züchtungsarbeit ist, Kartoffelsorten zu finden, die nicht so stark von Krautfäule und Kartoffelschorf angegriffen werden.
Da die Bedingungen für die Erzeugung von virusfreien Saatkartoffeln in Dänemark sehr günstig sind, hat man nicht viel Interesse daran, virusresistente Sorten zu züchten, mit Ausnahme von Kartoffelsorten für Export.
Auf der Station in Vandel befindet sich eine grössere Sammlung von wilden und kultivierten *Solanum*-Arten, die einer der Mitarbeiter der Station aus verschiedenen südamerikanischen Staaten mitgebracht hat.
Drei neue Sorten haben bei den vorläufigen Prüfungen gute Resultaten ergeben.

RÉSUMÉ

LE PROGRAMME DE L'OEUVRE SÉLECTIONNAIRE DE LA POMME DE TERRE AU DANEMARK

A partir de l'année 1948 l'oeuvre sélectionnaire de la pomme de terre au Danemark a pris un large essor. C'est que dans cette année fut instituée la „Caisse Agricole de la Pomme de terre", dont les fonds sont réservés en premier lieu à soutenir l'oeuvre sélectionnaire de la pomme de terre au Danemark. La „Caisse" exploite la Station d'expérimentation à Vandel qui, ensemble avec la Station d'essais à Tylstrup – également un institut de l'Etat – sont les seules institutions au Danemark où l'on se voue à l'oeuvre sélectionnaire de la pomme de terre.
La culture de la pomme de terre de consommation revêt une importance particulière, tout comme d'ailleurs celle des pommes de terre fourragères et industrielles.
Les propriétés des nouvelles variétés, telles que rendement et qualité, sont très importantes, mais l'un des objectifs de l'oeuvre sélectionnaire de nos jours est de créer des variétés de pommes de terre résistantes au mildiou et à la gale commune.
Etant donné que les conditions de production pour plants de pommes de terre exempts de toute contagion virologique sont très favorables au Danemark, on s'intéresse peu à la culture de variétés résistantes aux maladies à virus, sauf les variétés de pommes de terre destinées à l'exportation.
A la Station à Vandel on dispose d'une collection assez riche de variétés *Solanum* sauvages et cultivées en provenance de différents états américains et apportées par l'un des chercheurs de cet Institut.
Trois variétés ont fait l'objet d'expériences entreprises à titre provisoire, et elles ont donné de bons résultats.

WACHSTUMSREGULATOREN IM KARTOFFELBAU [1])

OTTO FISCHNICH, CHRISTOPH PÄTZOLD UND CLÄRE SCHILLER

Aus dem Institut für Pflanzenbau und Saatguterzeugung und dem Institut für Tierernährung, Braunschweig-Völkenrode (Deutschland)

Zusammenfassung in D., Fr. u. Eng. S. 29

1 EINLEITUNG

Die Verwendung von Wuchs- und Hemmstoffen im Gartenbau, in Forst- und Landwirtschaft – hier besonders zur Unkrautbekämpfung – ist schon weit verbreitet (u.a. 11, 15, 22, 2, 19, 12).

Im Kartoffelbau werden diese Stoffe in geringem Umfang zur Verhütung des Blütenfalles und Erzielung einer größeren Anzahl von Früchten (6), zur Förderung oder Hemmung des Sproßaustriebes von Knollen (8, 16, 10, 21, 4, 7, 9, 14), neuerdings auch zur vorbeugenden Unkrautbekämpfung – *pre-emergence treatment* (18) – sowie zur Abtötung von Unkraut in jungen Kartoffelbeständen herangezogen (1). Letzteres ist unter unseren Klima- und Kulturbedingungen nicht erforderlich. Hingegen kommt den Wuchs- und Hemmstoffen zur *Vernichtung von Spätunkräutern* eine gewisse Bedeutung zu (13). Bei Anwendung zu diesem Zweck gelangen sie je nach dem Zeitpunkt ihrer Applikation über Kartoffelblatt und Stengel nicht oder in mehr oder minder großem Umfange auch in die Knollen und verursachen *Keimhemmung* (17). Diese Eigenschaft nutzt man seit einigen Jahren, um Verluste bei der Lagerung zu verringern.

Der zunehmenden Verwendung von Chemikalien unter anderem zur Haltbarmachung von Lebensmitteln begegnet man von Seiten der Ernährungsforschung mit großer Zurückhaltung. Um klärend an dieser wichtigen Frage mitzuarbeiten, haben wir Fütterungsversuche mit Ratten angestellt. Dabei sollte festgestellt werden, ob der Verzehr behandelter Knollen sich ungünstig auf die Tiere auswirkt. Solche Versuche sind unseres Wissens noch nicht durchgeführt worden. Dagegen liegen zahlreiche Ergebnisse nach Oral- und sonstiger Applikation der reinen Substanzen an verschiedene Tierarten vor (22, 20, 3).

2 MATERIAL UND METHODIK

Bei den Versuchen zur Unkrautbekämpfung war es notwendig, auch die Empfindlichkeit der Kartoffelpflanze gegenüber Wuchs- und Hemmstoffen zu ermitteln. Hierzu

[1]) Elaborated from the text of a paper read at the Informal Potato Conference held at Lund, Sweden, 12th–15th Aug. 1957.

dienten Sorten aller Reifegruppen verschiedener Entwicklungsstadien. An Substanzen kamen in der Hauptsache zur Anwendung: Reines 2,4 D (Na-Salz) und verschiedene Salze des Hemmstoffes MH = Maleinsäurehydrazid (MH-Diäthanolamin-, MH-Triäthanolamin-, MH-Natriumsalz) in einer Konzentration von 0,001–1 %. Weiterhin wurden verwendet: 2,4 D-, MCP-, 2,4,5-T-Handelspräparate in einer Aufwandmenge wie zur Unkrautbekämpfung im Getreide. Unmittelbar vor der Kartoffelernte wurde Zahl und Gewicht der Unkräuter bestimmt und Bodenproben aus verschiedener Tiefe der Krume entnommen, um in ihnen am Auflaufen von Winterergerste und Raps eine eventuelle Nachwirkung der Wuchs- und Hemmstoffe zu prüfen. Bei der Ernte machten wir Ertragsfeststellungen (Gewicht, Sortierung) und sonderten Material zur Aufbewahrung für chemische Untersuchungen, Geschmackssteste, Nachbau und Verfütterung ab.

In Lagerungsversuchen wurde Material in Mieten, Kellern sowie unter konstanten Bedingungen (+ 18 °C) aufbewahrt und in Abständen das Knollen- und Keimgewicht ermittelt.

Für die Fütterungsversuche standen Albinoratten des amerikanischen Wistar-Stammes zur Verfügung. Diese Ratten sind durch jahrzehntelange Inzuchtvermehrung genetisch als weitgehend einheitlich anzusehen. Zur Verfütterung gelangten unbehandelte, über das Kraut beeinflußte sowie unmittelbar nach der Ernte behandelte Knollen der Sorte Bona als Grundfutter. Es sollte geprüft werden, *ob nach Verfütterung MH-behandelter Kartoffeln eine Beeinträchtigung der Fortpflanzungsfähigkeit und des sonstigen Gesundheitszustandes der Tiere eintritt.*

Hierfür dienten 3 Versuchsgruppen zu je 8 weiblichen und 2 männlichen Tieren. Gruppe I erhielt unbehandelte Knollen, Gruppe II Knollen MH-behandelter Pflanzen (0,4 % MH-Diäthanolaminsalz), Gruppe III mit MH-behandelte Knollen (1 % MH-Diäthanolaminsalz). Die Elterntiere wurden, nachdem die Jungtiere aufgezogen waren, getötet, ihre inneren Organe untersucht und der Versuch mit den kräftigsten Jungtieren (wiederum je 8 weibliche und 2 männliche Tiere) fortgesetzt. In dieser Weise konnten 4 Generationen (P, F_1, F_2, F_3) innerhalb eines Zeitraumes von 14 Monaten geprüft werden. Zur Vertiefung der Frage Gesundheitsbeeinflussung liessen wir die F_4 jeder Gruppe 8 Monate am Leben. Die Jungtiere wurden hierbei jeweils sofort nach der Geburt getötet. Sämtliche Elterntiere gelangten nach Beendigung des Versuches zur pathologisch-anatomischen Untersuchung [2]).

3 BEKÄMPFUNG VON SPÄTUNKRÄUTERN IM KARTOFFELBESTAND

a Mehrjährige Untersuchungen führten hier zu dem Ergebnis, daß *junge Kartoffelpflanzen* nach Wuchsstoffbesprühung, in Abhängigkeit von der angewandten Konzentration, mehr oder weniger stark geschädigt werden.

b Behandlung zum *Zeitpunkt der Blüte* begünstigt den Beerenansatz. Mit steigender Konzentration werden weniger keimfähige Samen in den Früchten gebildet.

c Voll entwickelte Kartoffelpflanzen, die zu vergilben beginnen, zeigen nach Wuchsstoffbehandlung (0,001 % bis 0,1 %) keine Schäden. Auf Unkräuter, die unter dem Kartoffelkraut bis zu diesem Zeitpunkt im Wachstum zurückgeblieben sind – hier

[2]) Diese Untersuchungen wurden dankenswerterweise vom Staatlichen Veterinäruntersuchungsamt in Braunschweig (Leiter: Regierungsveterinärrat Dr. Roemmele) durchgeführt.

besonders das in vielen Ländern in der Ausbreitung begriffene Franzosenkraut (*Galinsoga parviflora*) – wirken sie so, daß diese kümmern oder absterben. Bei Abreife der Kartoffelstauden ist die Fläche weitgehend unkrautfrei.
Den Erfolg einer solchen Behandlung veranschaulicht Abbildung 1.

ABB. 1. VERNICHTUNG VON SPÄTUNKRÄUTERN MIT WUCHSSTOFFEN
Wuchsstoffmittel *(Auxin):* 2,4-D-Aminsalz (Handelspräparat)
Tag der Behandlung *(Day of treatment):* 17.7.1956
Tag der Aufnahme *(Day of the photo):* 18.9.1956

Fig. 1. Killing of late weeds by Auxins

Die unkrautfrei gehaltenen Bestände lassen sich leicht roden. Es bleiben hiernach weniger Knollen im Acker. Dadurch verringert sich auch die Gefahr, daß Neuaustrieb in Nachfolgefrüchten (Getreide) entsteht.
Den besten Erfolg erzielten wir mit MCP-Mitteln. Auch 2,4-D- und andere Wuchsstoffpräparate waren brauchbar. Mit MH wurden ebenfalls gute Resultate gewonnen. Diese Wirkung ist für MH bisher nicht beschrieben worden.
Trotz der verhältnismäßig späten Wuchsstoff- und Hemmstoffspritzungen zeigten nach der Kartoffelernte gesäter Winterraps sowie verschiedene Winter- und Sommergetreidearten keine ungünstige Wachstumsbeeinflussung.

4 WIRKUNG VON WUCHS- UND HEMMSTOFFEN AUF DIE KNOLLE

a Behandlung des Krautes

Nach Wuchs- und Hemmstoffbehandlung des Krautes *junger Kartoffelpflanzen* war das Verhältnis der Knolleninhaltsstoffe zueinander gegenüber dem von Knollen un-

behandelter Pflanzen verändert. Es wurden z.T. auch Geschmacksbeeinträchtigungen festgestellt. Die Knollen wiesen während der Lagerung verzögerten Keimaustrieb auf. Das schließt eine Verwendung solchen Knollenmaterials als Pflanzgut und als Konsumware aus (5).

Wuchsstoffbehandlung von Pflanzen *unmittelbar vor dem Vergilben* führte zu keinen stofflichen Veränderungen in den Knollen und nicht zu Gesmacksbeeinträchtigungen. Hinsichtlich des Keimaustriebes verhielten sie sich wie solche unbehandelter Pflanzen. Nach entsprechender MH-Behandlung keimten die Knollen auch bei längerer Lagerung nicht, oder zeigten anomale Keime.

b Behandlung der Knolle

Wuchsstoffbehandlung der Knollen *im Anschluß an die Ernte* oder *nach Entkeimen im Frühjahr* hemmt bekanntlich die Keimentwicklung sehr gleichmäßig. Im Gegensatz zu anderen Autoren erzielten wir auch nach MH-Behandlung der Knollen unter besonderen Lagerungsbedingungen (hohe Luftfeuchtigkeit) eine lang anhaltende Keimhemmung.

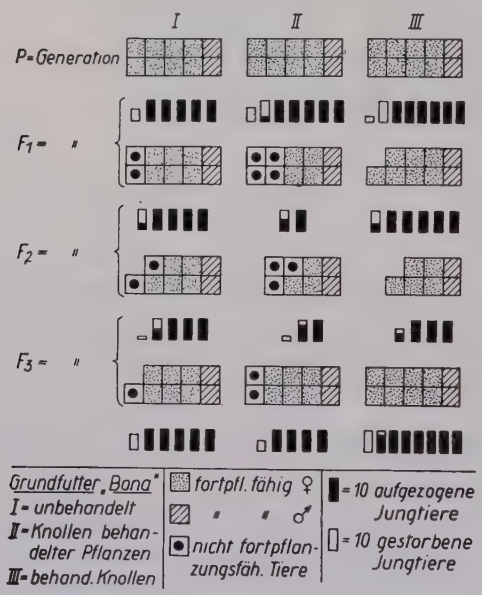

ABB. 2. FORTPFLANZUNGSFÄHIGKEIT VON ALBINORATTEN NACH VERFÜTTERUNG MH-BEHANDELTER KARTOFFELN[3])

Fig. 2. Reproduction ability of Wistar-rats

5 FÜTTERUNGSVERSUCHE

Schweine und Ratten nahmen Knollen behandelter Pflanzen oder behandelte Knollen ebenso auf wie unbehandelte Kartoffeln und verwerteten sie normal.

Auf die Frage, ob nach MH-Behandlung die Fruchtbarkeit der Versuchstiere beeinflusst wird, gibt der über mehrere Generationen durchgeführte Versuch Aufschluß (Abb. 2).

Bei der den Versuch einleitenden Rattengeneration (P) zeigten sich in der Fruchtbarkeit keine Unterschiede zwischen den Fütterungsgruppen. In der nächsten (F_1) und übernächsten Generation (F_2) wurden in der Fütterungsgruppe II, welche Knollen MH-behandelter Pflanzen als Grundfutter erhielt, weniger fortpflanzungsfähige Tiere und wesentlich weniger geborene oder aufgezogene Jungtiere als in der Kontrollgruppe (I) gezählt. Auch das Verhalten und das Aussehen der Tiere ließ zu wünschen übrig. Im Gegensatz

[3]) Die Differenzen zwischen den Behandlungen und der Kontrolle sind schwach signifikant mit $P = 0{,}05$.

dazu war das Ergebnis der Gruppe III (Grundfutter: unmittelbar mit MH-behandelte Knollen) günstig. In der folgenden Generation (F_3) und weiterhin wurden in den Versuchsgruppen hinsichtlich der Fruchtbarkeit keine schlechteren, zum Teil sogar bessere Ergebnisse als in der Kontrollgruppe festgestellt. Die anatomische Untersuchung der Muttertiere brachte bei den Tieren aller Versuchsgruppen normale Befunde (siehe auch 3).

Untersuchungen zur Frage, ob auch Knollen wuchsstoffbehandelter Pflanzen nach Dauerfütterung die Gesundheit der Versuchstiere beeinträchtigen, laufen noch.

ZUSAMMENFASSUNG

WACHSTUMSREGULATOREN IM KARTOFFELBAU

Spätverunkrautung in Kartoffelbeständen – besonders „Franzosenkraut" (*Galinsoga parviflora*) – kann durch Spritzung von Wuchs- und Hemmstoffen unmittelbar vor dem Vergilben der Kartoffelpflanzen unterdrückt werden.

Hierdurch wird eine Ernteerleichtung ermöglicht, und es verbleiben weniger Knollen in der Erde.

Eine *so späte* Wuchsstoffspritzung wirkt sich weder bei Konsumware noch auf Pflanzgut ungünstig aus.

Nach entsprechender Verwendung von Maleinsäurehydrazid beobachtet man lang anhaltende Keimhemmung im Lager. Das schließt dessen Anwendung im Rahmen der Pflanzguterzeugung aus.

In Fütterungsversuchen haben Knollen MH-besprühter Pflanzen nach Aufnahme über längere Zeit Fertilitätsstörungen bei *Ratten* verursacht. Unmittelbar mit diesem Stoff behandelte Kartoffelknollen erbrachten auch bei langfristiger Verfütterung keine Störungen dieser Art.

RÉSUMÉ

LA PULVÉRISATION DES HORMONES VÉGÉTALES DANS DES CULTURES DE POMMES DE TERRE

Des mauvaises herbes dans des cultures de pommes de terre – tout en particulier *Galinsoga parviflora* – peuvent être combattues par un traitement aux hormones végétales, qui seront pulvérisés au moment où les tiges, touchant à la maturité, commencent à jaunir.

De cette façon la récolte mécanique se fait plus facilement et le nombre des tubercules restant dans le sol, est réduit.

La pulvérisation des hormones végétales à un stade si tardif n'aura de mauvais effets ni sur les plants, ni sur les pommes de terre de consommation.

Un emploi adéquat d'hydracide maléique retarde le moment où les tubercules commencent à germer. Or, on ne peut s'en servir pour la production de plants.

Incorporés dans des rations que reçoivent des rats, impliqués dans des expériences alimentaires, pendant une longue période, des tubercules de pommes de terre traités à l'hydracide maléique causaient des troubles dans la fécondité de ces animaux. Lorsque, par contre, les rats reçoivent des tubercules de pommes de terre immédiatement traités à cette préparation, et ce à une date bien reculée, ces symptômes ne se produisent pas. L'état de santé des rats n'en est pas affecté.

SUMMARY

THE USE OF GROWTHREGULATING SUBSTANCES ON POTATOCROPS

Late weeds in potato crops, especially *Galinsoga parviflora*, may be destroyed by spraying with growth regulating substances when the haulm is becoming yellow with approaching maturity.

In this way mechanical harvesting is made easier and the number of tubers left in the soil is reduced.

Spraying with growth regulating substances at this late stage has no harmful effect on either seed or ware crops.

Similar treatment with maleic hydrazide prolongs tuber dormancy and should not be applied to seed crops.

Long-term feeding trials showed that if rats were maintained on a diet including tubers from plants sprayed with maleic hydrazide disturbances in the level of fertility occurred. No such effect was noted where the diet included tubers treated with maleic hydrazide after lifting.

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METHODE ZUR BEOBACHTUNG DER ENTWICKLUNG DER VIRUSÜBERTRAGENDEN BLATTLÄUSE ZWECKS ANSETZUNG DES FRÜHERNTETERMINS UND DESSEN RÜCKWIRKUNGEN AUF DEN ERTRAG AN SAATKARTOFFELN [1]

J. MÜNSTER
Stations fédérales d'essais agricoles, Lausanne (Suisse)

Zusammenfassung in D., Fr. u. Eng. S. 39

1 DIE ANSETZUNG DES FRÜHERNTETERMINS

In Anlehnung an die in den Niederlanden erzielten Erfolge mit der Frühernte und nach mehrjähriger Nachprüfung dieser Arbeitsmethode in der Schweiz erklärten die beiden Eidgenössischen landwirtschaftlichen Versuchsanstalten Zürich-Oerlikon und Lausanne ab 1948 die Frühernte als obligatorisch für alle in Klasse A anerkannten Saatkartoffelbestände (6, 7). Die Einführung der Frühernte (Staudenausziehen oder Abbrennen) bildet eine der Hauptursachen für die in den letzten Jahren erzielten Fortschritte in der inländischen Qualität. Doch sei vorweg gesagt, dass von der Frühernte nur dann ein Erfolg erwartet werden kann, wenn der Frühern tetermin in genauester Beachtung der Blattlausentwicklung und des Massenfluges angesetzt wird. Die teilweise noch in gewissen Kreisen bestehende Auffassung, dass die Frühernte bei beginnender Gelbreife der untern Kartoffelblätter durchzuführen sei, muss als unzutreffend bezeichnet werden.

In unserm Arbeitskreis umfasst die Ueberwachung der Entwicklung der Blattläuse folgende Arbeitsphasen (1):

Kontrolle der Ueberwinterung der Blattläuse im Freien. Jährlich Ende Januar – Anfangs Februar durchgeführte Erhebungen in Freilandkulturen ergaben, dass für schweizerische Verhältnisse die Möglichkeit einer Ueberwinterung nur selten besteht.

Kontrolle des Ausschlüpfens der Stammütter der Pfirsichblattlaus auf den Pfirsichbäumen (speziell auf Spalieren). Da auf dem Pfirsichbaum die Entwicklung der folgenden Generationen (*Fundatrigenia aptera*) stark von der im März und April herrschenden Witterung abhängt, bietet das Datum des Ausschlüpfens der Stammütter keinen ausschlaggebenden Anhaltspunkt über das voraussichtliche Ausmass der Entwicklung; wichtiger ist hingegen, das Auftreten der ersten Nymphen und der geflügelten Pfirsichblattläuse auf dem Pfirsichbaum festzustellen, um so eine Prognose über den mutmasslichen Beginn des ersten Anfluges in die Kartoffelfelder aufstellen zu können.

[1] *Lecture delivered at Lund, August 1957.*

Gelbschalenmethode zur Feststellung des Befallfluges der Blattläuse. Die im Verlaufe der letzten Jahre durchgeführten Versuche bestätigten, dass die Gelbschalenmethode zur Feststellung des Befallfluges der Blattläuse in den Kartoffelfeldern nicht befriedigend funktioniert und dass uns geeignete Blattproben diesbezüglich besser unterrichten.

Dank der finanziellen Hilfe der Saatzuchtgenossenschaften kann die Ueberprüfung der Blattproben auf Blattlausbefall einheitlich in der Versuchsanstalt durchgeführt werden.
Die Blätter werden zu je 5 Proben (anfänglich 40, später 20 Blätter pro Probe) wöchentlich von ungefähr 70 auf die Saatgutproduktionsgebiete verteilten Posten entnommen und in hierzu speziell angefertigten Packungen der Versuchsanstalt eingesandt. Wird die Probenentnahme ordnungsgemäss und sorgfältig durchgeführt, so können mittelst der Blattproben die ersten vom Pfirsichbaum oder von Nebenwirtspflanzen kommenden geflügelten viviparen Weibchen schon vor dem Absetzen der ersten Larven erfasst werden (1).

Bestimmung des Beginns des Massenfluges. Nun ist es wichtig, den Beginn des Massenfluges zu bestimmen, welcher in der Schweiz in Zusammenhang mit den grossen Unterschieden der topographischen Lage von Gebiet zu Gebiet grossen Schwankungen unterworfen ist. Wohl kann mittelst der Gelbschalen der Massenflug gut verfolgt werden, doch ist es uns praktisch nicht möglich, alle die Fänge innert nützlicher Frist auszuwerten und alsdann den Früherntetermin noch rechtzeitig den Experten mitzuteilen, insbesonders da dieser Termin, wenn das Feld totgespritzt wird, noch um 5 Tage vorverlegt werden muss. Freilandversuche zeigten, dass in gut isolierten Beständen die ersten Infektionen der Knollen ca. 14 Tage nach Beginn des Massenfluges oder 8 Tage nach Erreichung des Kulminationspunktes stattgefunden haben.

Auftreten der ersten Nymphen und Bestimmung deren Anzahl. Aus diesen Gründen legen wir grössten Wert auf eine genaue Beobachtung des Auftretens der ersten Nymphen und der Bestimmung deren Anzahl; dies ermöglicht uns eine Prognose über die vermutliche Intensität des Massenfluges zu stellen. Sind die klimatischen Bedingungen während der Entwicklung der Nymphen normal (Witterung nicht zu kalt, keine anhaltende Niederschläge), so beginnt der Massenflug ungefähr 8 Tage nach dem Auftreten der ersten Nymphen. Wir sind uns jedoch bewusst, dass die Intensität des Massenfluges, welcher für die Verbreitung der Virosen von grösster Bedeutung ist, allein mit den Fangschalen genauestens verfolgt werden kann, weshalb wir in besonders exponierten Lagen dieselben in beschränktem Masse benützen. Ergeben sich dann auf Grund der Fangschalenergebnisse widersprechende Resultate zu der von uns durch Feststellung der Nymphen gestellten Prognose, so erfolgt die Korrektion des bereits angesetzten Früherntetermins telephonisch an die Feldbesichtigungsexperten.

Heute noch ist jeder Saatgutproduzent verpflichtet, den vom Experten angesetzten Früherntetermin genau innezuhalten, ansonst sein Bestand in Klasse B abgestuft wird. Da wir aber durch Einführung des IGEL-LANGE-Testes (I.L.T.) in der Lage sind, das Saatgut auch nach der Ernte auf den Befall an Blattroll, zum Teil auch an schweren Mischinfektionen zu überprüfen (8), könnte unter Umständen inskünftig dem Produzenten in der Ansetzung der Frühernte etwas freiere Hand gelassen werden und wir könnten uns darauf beschränken, diese Daten als Richtlinien herauszugeben. *Die*

Höhenlage für sich allein ist kein endgültiger Wertmesser für die Beurteilung der Eignung eines Gebietes. Seien wir uns klar, dass sogar auf engstem Raum, innerhalb ein und derselben Ortschaft, die Blattlausentwicklung verschieden verlaufen kann. Theoretisch gesprochen sollte somit der Früherntetermin von Feld zu Feld verschieden angesetzt werden, was aber nicht möglich ist.

Aus diesem Grunde möchten wir mit der Zeit dazu übergehen, dass die Eidgenössischen landwirtschaftlichen Versuchsanstalten wie bis anhin die Früherntetermine gebietsweise festlegen, dass es aber den Produzenten frei steht, denselben auf eigene Verantwortung und auf Grund eingehender Beobachtungen der Blattläuse und vor allem der Entwicklung des eigenen Bestandes (Nähe von Infektionsquellen, Gründlichkeit der Säuberung des Bestandes von viruskranken Pflanzen, etc.) um einige Tage zu verschieben. Dies aber unter der Bedingung, dass nach erfolgter Ernte eine genügend grosse Anzahl Knollen durch die Versuchsanstalt mittelst einer geeigneten Methode auf Virusbefall untersucht wird. Ergibt die Untersuchung einen überdurchschnittlichen Krankheitsbefall, so würde der Posten in Klasse B abgestuft, dies ohne Anspruch auf Preisentschädigung für durchgeführte Frühernte.

2 EINFLUSS DER FRÜHERNTE AUF DEN ERTRAG

Durch die Frühernte wird die Vegetationszeit auf ca. 85–110 Tage verkürzt, was, je nach Gebiet und Kartoffelsorte, wohl zu erheblichen Einbussen des Gesamtertrages führt, aber den Anfall an Knollen in Saatgutgrösse nicht wesentlich beeinträchtigt. Durch verbesserte Anbaumethoden, Verlegung der Saatgutproduktion in hierfür geeignete Lagen und finanzielle Beiträge seitens der eidg. Behörden und der Vereinigung schweizerischer Importeure für Saatkartoffeln wird versucht, den durch die Frühernte verursachten Ertragsausfall preislich auszugleichen.

Die im Verlauf der Jahre 1953/55 von uns zusammen mit einigen landwirtschaftlichen Schulen in verschiedenen Saatkartoffelgebieten angelegten Versuche zwecks Studium der Produktionsbedingungen der Klasse A (Frühernte), der Knollenentwicklung und der Ertragszunahme während der Wachstumsperiode ergaben mannigfaltige Ergebnisse, auf welche wir anschliessend etwas eingehen möchten (2).

Gestützt auf die Veröffentlichungen von MADEC et PERENNEC (4, 5), KRIJTHE (3) und unsere Versuche kann der Verlauf des Knollenwachstums schematisch wie folgt dargestellt werden:

Nach Sorten unterschiedlich, beginnt bei vorgekeimten Knollen der Knollenansatz ca. 5–6 Wochen nach dem Auspflanzen. 2–3 Wochen später setzt das eigentliche Knollenwachstum ein, welches ziemlich konstant bis kurz vor der Reife der Pflanze anhält, dies unter der Voraussetzung, dass die Kartoffel in ihrer Entwicklung nicht durch anormale Witterungsverhältnisse gehemmt wird. Je nach Sorte beträgt der tägliche Ertragszuwachs an Knollen 5–7 kg/Are; er kann aber bei gewissen Sorten, wie Sirtema, Bona, Voran und Benedikta kurz vor dem Früherntetermin noch höhere Werte einnehmen.

FIG. 1. SCHEMATISCHE DARSTELLUNG DES VERLAUFS DES KNOLLENWACHSTUMS UND ERTRAGES
Typen I, II, III und IV: Höhe der Erträge bei den Klassen A und B.
Zeitabschnitte a, b, c und d: Stand der Knollenentwicklung.

Fig. 1. Représentation théorique de la tubérisation. Evolution du rendement des catégories de calibre
Types I, II, III et IV: niveaux de récolte, classes A et B.
Intervalles a, b, c et d: stades de tubérisation.

Fig. 1 stellt den Verlauf des Knollenwachstums, untergeteilt in Sortierungsgrössen <30, 30–35, 35–50 (55) und >50 (55) mm Quadratsiebdurchmesser dar. Diese schematische Darstellung ist in die vier Abschnitte a, b, c und d untergeteilt; während dem Zeitabschnitt a erfolgt die Differenzierung der Knollenknospen. Im Verlauf der folgenden Zeitabschnitte b–d finden fortlaufend Uebergänge der untern Knollengrössen zu den obern Knollengrössen statt. Das Gewicht der Knollengrössen <30 und 30–35 mm bleibt nach Abschluss des Zeitabschnittes b ziemlich konstant und übt keinen wesentlichen Einfluss auf den Ertrag aus, während die Saatgutgrösse 35–50 (55) mm ab Beginn des Zeitabschnittes c zu Gunsten der Speisekartoffelsortierung >50 (55) mm progressiv abnimmt.

a Das Vorkeimen des Saatgutes

Bei den oben angeführten Versuchen gingen die vorgekeimten Knollen im Durchschnitt 11 Tage früher auf als die nicht vorgekeimten. Die Dauer der sich zwischen dem Pflanzdatum und dem Aufgehen erstreckenden Zeitperiode kann als Wertmesser wie auch Masstab für die Güte der Vorbereitung des Pflanzgutes benützt werden. Je länger diese Zeitperiode ist, umso geringer wirkt sich die Vorkeimung auf den Ertragszuwachs gegenüber dem nicht vorgekeimten Saatgut aus.

Damit der durch das Vorkeimen erzielte Vorsprung voll ausgenützt werden kann, müssen nach dem Auflaufen günstige Wachstumsbedingungen, vor allem in Bezug auf Bodentemperatur, vorhanden sein. Ich wiederhole, dass der Früherntetermin von den Versuchsanstalten unabhängig vom Knollensatz, unter sorgfältigster Beachtung der Blattlausentwicklung angesetzt wird. Der durch die Vorkeimung erzielte Wachstumsvorsprung gegenüber nicht vorgekeimten Saatgut wirkte sich beim Früherntedatum

(im Durchschnitt der Jahre zweite Hälfte Juli für Lagen unterhalb 600 m über Meer) in einem durchschnittlichen Mehrertrag von 50,6 kg/Are bei Bintje und 54,1 kg/Are bei Ackersegen aus. Das entspricht also einer täglichen Ertragszunahme von nahezu 500 kg pro Hektare und einem Mehrertrag von 26 %. Der Ertragszuwachs entfällt vor allem auf die beiden Sortierungsgrössen 35–50 (55) und > 50 (55) mm. Bei der Saatgutgrösse 35–50 (55) mm beträgt der durchschnittlich erzielte Mehrertrag bei Bintje 39,4 kg/Are und bei Ackersegen 42,7 kg/Are; in der Sortierung 50 (55) mm und grösser 20,4 kg/Are respektive 17,1 kg/Are. Bei den beiden untern Sortierungen (< 30 mm und 30–35 mm) ist der Ertrag hingegen gegenüber dem nicht vorgekeimten Saatgut etwas geringer.

b Verlauf der Knollenentwicklung

Geschwindigkeit und Umfang der Knollenentwicklung sind vor allem abhängig von der Sorte, dem Keimzustand des Saatgutes, den Wachstumsbedingungen nach dem Auspflanzen und der Dauer der Vegetationsperiode. Diese Einflüsse können durch 3 zweiwertige Faktoren ausgedrückt werden:

1 Früher oder später Knollenansatz (schliesst den Sorteneinfluss und die Wachstumsbedingungen ein).
2 Kurze oder lange Vegetationsperiode (Einfluss der Frühernte (früh oder spät) und der Ernte bei Vollreife).
3 Vorgekeimtes oder nichtvorgekeimtes Saatgut.

Je nach Kombination dieser verschiedenen Einflussfaktoren geht die Knollenentwicklung rascher oder langsamer vor sich, entsprechend den in Fig. 1 dargestellten vier Phasen a–d. Im allgemeinen kann der Zustand der Knollenentwicklung anlässlich der Frühernte (Klasse A) in die Phasen b oder c, derjenige anlässlich der Späternte (Klasse B) in die Abschnitte c oder d eingegliedert werden. Indem wir jedem der oben unter 1–3 angeführten Punkte, entsprechend ihrem positiven oder negativen Einfluss auf den Ertrag, ein + oder – Zeichen geben, können diese Faktoren in vier Gruppen zusammengefasst werden, wie sie in Fig. 2 dargestellt sind.

tubérisation = Knollenentwicklung
tubérisation précoce = frühe Knollenentwicklung
tubérisation tardive = longe Knollenentwicklung
période de végétation = Wachtstumperiode
période de végétation longue = lange Wachtstumperiode
période de végétation courte = kurze Wachtsumperiode
sans prégermination = ohne Vorkeimung
avec prégermination = mit Vorkeimung

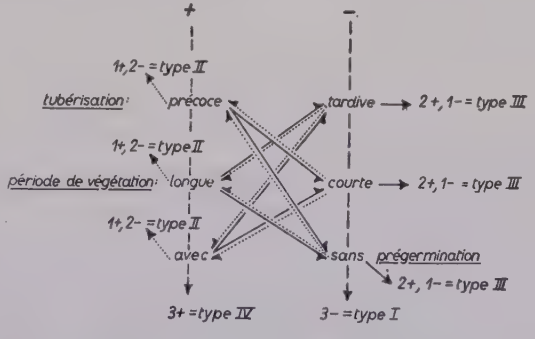

FIG. 2. KOMBINATIONSMÖGLICHKEITEN VON DREI DIE KNOLLENENTWICKLUNG BEEINFLUSSENDEN FAKTOREN, NACHE. JOSEPH U.A. (2)

Fig. 2. Combinaisons de trois facteurs déterminant la tubérisation.

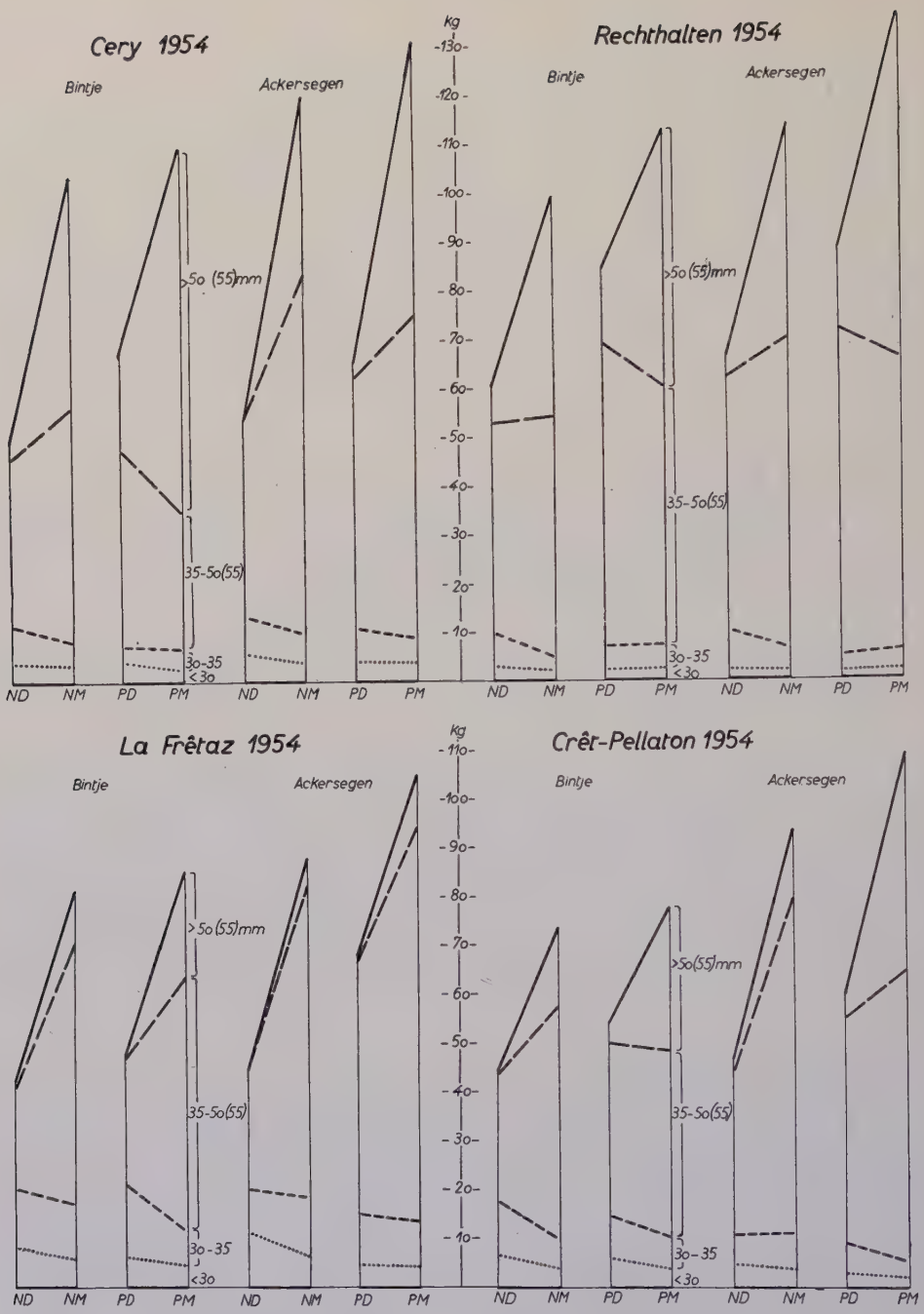

FIG. 3. VERLAUF DER KNOLLENENTWICKLUNG FÜR DIE IN CERY, RECHTHALTEN, LA FRÊTAZ UND CRÊT-PELLATON ANGELEGTEN VERSUCHE (KG/25 M²)

Fig. 3. Comparaison du rendement de chaque traitement réparti selon le calibre, pour quatre essais (kg/25 m²)

ND = { *Non prégermés, destruction des fanes* / Nicht vorgekeimt, Kraut gezogen

NM = { *Non prégermés, récolte à maturité* / Nicht vorgekeimt, Ernte bei Vollreife

PD = { *Prégermés, destruction des fanes* / Vorgekeimt, Kraut gezogen

PM = { *Prégermés, récolte à maturité* / Vorgekeimt, Ernte bei Vollreife

ENTWICKLUNG DER BLATTLÄUSE UND FRÜHERNTE

Auf der linken Senkrechte der Fig. 2 befinden sich die positiven Faktoren, wie früher Knollenansatz, lange Vegetationsperiode und Vorkeimung, während auf der rechten Senkrechte die die Knollenentwicklung negativ beeinflussenden Punkte aufgezählt sind. Durch Kombination der Faktoren: früher Knollenansatz, lange Vegetationsperiode, keine Vorkeimung kommen wir zu der in Fig. 2 auf der rechten Senkrechte von unten an gezählten zweiten Kombinationsmöglichkeit: 2+, 1– = = Typ III, welche bei der Ernte dem in Fig. 1, Abschnitt c, dargestellten Knollenentwicklungszustand entspricht.

Fig. 3 stellt das tatsächliche Ergebnis dieser Kombinationsmöglichkeiten für 4 Versuchsorte mit den Sorten Bintje und Ackersegen dar und versetzt uns in die Lage, unter Beiziehung der Fig. 1, für jedes Versuchsergebnis die Knollenentwicklung zu illustrieren und die diese beeinflussenden Faktoren zu beurteilen. So fällt z. B. die in Fig. 3 unter Cery 1954, Bintje, stehende Säule ND–NM in Fig. 1 unter Typ II, während die folgende Säule PD–PM in den Abschnitt IV einzugliedern ist.

Noch sei kurz auf die Wirtschaftlichkeit der Klasse A im Vergleich zur Klasse B hingewiesen. Der Preisunterschied des Saatgutes für den Produzenten betrug, bei Bintje, zwischen A und B im Verlauf der letzten Jahre Fr. 9.— und bei Ackersegen

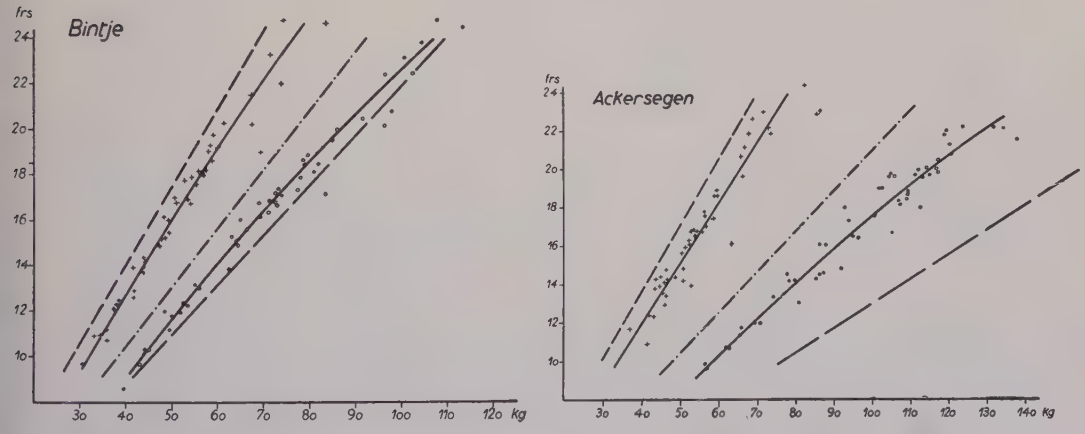

FIG. 4. ROHERTRAG IN FRANKEN IN BEZIEHUNG ZUM ERNTEERTRAG IN KG/25M²

Fig. 4. Rendement brut en frs en fonction du rendement en kg/25 m²

Erklärung *(Légende)*:

\+ Rohertrag in Fr. bei Klasse A
Rendements de classe A

o Rohertrag in Fr. bei Klasse B
Rendements de classe B

– – – – Rohertrag in Fr. bezogen auf 35–50 mm Klasse A
Rendements en frs calculés sur la base 35–50 mm classe A

–·–·–·– Rohertrag in Fr. bezogen auf 35–50 mm Klasse B
Rendements en frs calculés sur la base 35–50 mm classe B

—— —— Rohertrag in Fr. bezogen auf > 50 mm
Rendements en frs calculés sur la base >50 mm

———— Durchschnittserträge für die Klassen A und B
Courbe moyenne de classe A et de classe B

Fr. 13.— pro 100 kg. Auf Grund dreijähriger Versuche ergab sich nun das in der Fig. 4 graphisch dargestellte Rentabilitätsverhältnis zwischen A und B.

Zur Erklärung des Fig. 4 sei folgendes Beispiel angeführt: Man ziehe von den auf den beiden Abzissen liegenden Punkten 50 kg (Bintje) und 55 kg (Ackersegen) je eine Senkrechte bis zur Kurve: Durchschnittserträge für Klasse A. Durch den Schnittpunkt dieser beiden Linien wird eine Horizontale geführt, welche für Bintje die Ordinate im Punkt Fr. 16,— und für Ackersegen bei Fr. 17,— kreuzt. Durch Verlängerung dieser Horizontalen nach rechts bis zur Kurve: Durchschnittserträge für Klasse B und Aufzeichnung einer Senkrechten zur untenliegenden Abzisse fällt man auf die beiden Ertragszahlen 70 kg (Bintje) und 95 kg (Ackersegen). Dies heisst, mit einem Ertrag von 50 kg/Are bei Bintje, Klasse A, müssen in Klasse B hingegen mindestens 70 kg/Are anfallen, damit letztere Anbaustufe ersterer preislich gleichgestellt ist.

Im weitern ist diesen beiden Figuren zu entnehmen, dass die durch die Frühernte zum Teil wesentlich verkürzte Vegetationsperiode und die dadurch bewirkte Erniedrigung des Gesamtertrages nebst den üblichen Preiszuschlägen durch einen höhern Anfall an Saatgut wettgemacht werden muss. Entsprechend den erhaltenen Versuchsergebnissen ist die Wirtschaftlichkeit der Klasse A gegenüber der Klasse B gesichert, sobald der bei der Frühernte festgestellte Totalertrag bei Bintje ungefähr 200 kg und bei Ackersegen 220 kg/Are und mehr erreicht.

3 WELCHE PRAKTISCHEN SCHLUSSFOLGERUNGEN HABEN DIE SCHWEIZERISCHEN SAATZUCHTORGANISATIONEN ZU ZIEHEN?

Der zwischen dem Pflanzdatum und dem Früherntetermin liegende Zeitabstand ist unter unsern Verhältnissen in den zwischen 600–900 m liegenden Gebieten am grössten. Unterhalb 600 m erfährt er infolge des relativ frühen Blattlausanfluges und des damit früher angesetzten Früherntetermins eine Kürzung, während in Gebieten über 900 m die Vegetationsperiode im allgemeinen durch die spätere Anpflanzung verkürzt wird. Aus diesem Grunde besteht bisweilen bei den in tiefern Lagen anbauenden Saatgutvermehrern die Tendenz, die Erzeugung von Klasse B (Ernte bei Vollreife) derjenigen der Klasse A (Frühernte) vorzuziehen. Solche Produktionslagen sind aber den dem Früherntetermin folgenden Massenflug der Blattläuse allgemein stark ausgesetzt, weshalb hier die Anbaustufe B in erheblich höherm Masse als in mittlern Höhenlagen durch Virusinfektionen gefährdet ist. Es soll damit gesagt sein, dass Tieflagen, welche sich in wirtschaftlicher Hinsicht nicht für den Anbau von Klasse A eignen, ebenfalls nicht für die Produktion der Anbaustufe B in Betracht gezogen werden dürfen.

Aus diesen Gründen ist eine weitere Ausdehnung des Saatkartoffelanbaues nur in solchen Gebieten zu fördern, wo die beiden Faktoren: Qualitätsproduktion und Wirtschaftlichkeit der Klasse A, miteinander vereinigt werden können. Durch eine Konzentration der Saatkartoffelbestände verringert man gleichzeitig das Vorhandensein schlechter Saatgutbestände, welche stets gefürchtete Virusherde bilden.

Die Auswertung des Zahlenmaterials und die Aufstellung der Graphiken erfolgte durch meinen Mitarbeiter E. JOSEPH, Ing. agr., wofür ich ihm wärmstens danke.

ZUSAMMENFASSUNG

METHODE ZUR BEOBACHTUNG DER ENTWICKLUNG DER VIRUSÜBERTRAGENDEN BLATTLÄUSE ZWECKS ANSETZUNG DES FRÜHERNTETERMINS UND DESSEN RÜCKWIRKUNGEN AUF DEN ERTRAG AN SAATKARTOFFELN

Der Frühernte ist nur dann ein Erfolg gesichert, wenn deren Termin in engster Beobachtung der Blattlausentwicklung, vor allem des Beginns und der Intensität des Massenfluges, angesetzt wird. Die Ueberwachung der Blattlausentwicklung erstreckt sich, zusammengefasst, auf folgende Arbeitsphasen:

1 Kontrolle der Ueberwinterung von lebenden Blattläusen im Freiland und im Eistadium auf dem Pfirsich.
2 Kontrolle des Ausschlüpfens der ersten Stammütter, des Auftretens der ersten Nymphen und geflügelten Weibchen auf dem Pfirsich.
3 Kontrolle der Vermehrung der Blattläuse in den Kartoffelkulturen und Einschätzung des Beginns und des Ausmasses des folgenden Massenfluges.

Die Frühernte verkürzt, je nach Sorte und Gebiet, die Vegetationsperiode auf ca. 85–110 Tage und führt zu dementsprechenden Ertragseinbussen, welche nach Möglichkeit durch verbesserte Anbaumethoden und eine Erhöhung des Saatgutpreises zu kompensieren sind.

Die im Verlaufe der Jahre 1953/55 in verschiedenen zwischen 435 m und 1250 m ü. M. liegenden Orten des Juras, des Mittellandes und des Wallis angelegten Versuche ergaben folgendes:

Die Wirtschaftlichkeit der Klasse A (Frühernte) gegenüber der Klasse B (Normalernte) ist gesichert, sobald der anlässlich dem Früherntetermin festgestellte Totalertrag – welcher sich zu diesem Zeitpunkt vorwiegend aus Saatgut der Grösse 35–50 (55) mm zusammensetzt – bei Bintje ungefähr 200 kg und bei Ackersegen 220 kg/Are und mehr erreicht. Um aber solche Erträge zu erzielen, ist das Vorkeimen des Saatgutes unerlässlich. Das Vorkeimen beschleunigte das Aufgehen des Saatgutes um durchschnittlich 11 Tage und erhöhte anlässlich der Frühernte den Ertrag bei Bintje um 50,6 kg, bei Ackersegen um 54,1 kg/Are (26%).

Der zwischen dem Pflanzdatum und dem Früherntetermin liegende Zeitabstand ist vorwiegend in zwischen 600–900 m liegenden Gebieten am ausgedehntesten. Unterhalb 600 m erfährt er infolge des relativ frühen Blattlausbefalls eine Kürzung, während in Lagen über 900 m die Vegetationsdauer durch das späte Pflanzdatum eingedrängt wird.

In der mittleren Zone besteht am ehesten die Gewähr, dass der mit der Klasse A erzielte Bruttoertrag in Franken gleich oder höher demjenigen der bei in Vollreife geernteten Saatgutbeständen (Klasse B) ist.

RÉSUMÉ

MÉTHODE UTILISÉE EN SUISSE POUR SUIVRE L'ÉVOLUTION DES PUCERONS VECTEURS DES MALADIES À VIRUS, EN VUE DE FIXER LE JOUR A – RÉPERCUSSIONS DE LA RÉCOLTE HÂTIVE SUR LE RENDEMENT EN PLANTS

La récolte hâtive (arrachage ou destruction prématurée des fanes) n'atteint son but qu'à la condition d'en déterminer la date par une observation aussi minutieuse que possible de l'évolution des pucerons vecteurs de virus, notamment du début et de l'intensité du vol massif.

En résumé, le contrôle des pucerons comprend les travaux suivants:

1 Contrôle de la présence de pucerons passant l'hiver par voie agame sur des cultures ou à l'état d'oeuf sur le pêcher.
2 Contrôle des dates de l'éclosion des fondatrices, de l'apparition des nymphes et des ailés migrateurs se trouvant sur les pêchers.
3 Contrôle de l'évolution des pucerons dans les cultures de pommes de terre et supputation du début et de l'intensité probable du vol massif.

Par une récolte hâtive la période de végétation est réduite, selon la variété et le lieu de culture, à 85–110 jours. Il en résulte une diminution du rendement, qui doit être compensée d'une part par une intensification de la culture et d'autre

part par une augmentation du prix de vente du plant.
Des essais exécutés durant les années 1953/55 dans différentes régions échelonnées entre 435 m et 1250 m d'altitude dans le Jura, sur le Plateau et en Valais, font ressortir l'importance des quelques facteurs énumérés ci-dessous:
Seule une récolte assez élevée au jour A (200 kg/a pour Bintje et 220 kg/a et plus pour Ackersegen), et comprenant en majorité des plants du calibre 35–50 (55) mm, est en mesure de compenser l'accroissement de la récolte intervenant jusqu'à la maturité et de réaliser en classe A un rendement brut égal ou supérieur à celui des cultures de classe B.
La prégermination des plants est indispensable pour atteindre ce niveau de récolte au jour A. Elle avance la levée de 11 jours en moyenne et hâte le développement des plantes. Il en résulte un surplus de rendement de 50–55 kg/are au jour A (26%).
Limitée dans les cultures de classe A par la date de plantation et celle de la destruction prématurée des fanes, la durée de la végétation s'avère en général la plus longue dans les zones d'altitude moyenne (600–900 m). Elle est plus courte à des altitudes basses par suite de l'apparition précoce des pucerons vecteurs de viroses et à des altitudes plus élevées en raison de la plantation tardive. C'est dans ces zones d'altitude moyenne que l'on peut obtenir des cultures de plants de classe A un rendement brut égal ou supérieur à celui des cultures récoltées à maturité (classe B).

SUMMARY

METHOD OF CONTROLING THE APHID VECTORS OF VIRUSES BY MEANS OF EARLY HARVESTING, AND THE CONSEQUENCES TO THE PRODUCTION OF SEED-POTATOES

Early harvesting (premature hand-pulling of potato haulm or haulm destruction) can only be expected to be effective when it is timed to take into account as closely as possible the development of the aphid virus vectors, especially the beginning and intensity of the mass flight. The steps to be taken for this purpose are as follows:

1 Survey of the presence of aphides overwintering as parthenogenetic viviparous females (on cruciferae) or in the egg stage on peach.
2 Determination of the dates of hatching of the eggs giving rise to the fundatrices and of the appearance of nymphs and winged migrants from peach.
3 Survey of the aphid movement within the potato crops and estimate of the first appearance and probable density of the mass infestation.

This practice shortens the growth period which may be reduced to approximately 85–110 days, according to the variety and locality of the crop. The decrease in yield resulting from early harvesting should be offset by an increased crop on the one hand and a higher seedprice on the other.
Trials undertaken during 1953–1955 in different districts where seed potatoes are grown at altitudes varying between 435–1250 metres, situated in the Jura, on the Plateau and in the Canton of Valais, bring out the importance of certain factors indicated below:
Only a sufficiently high yield on day A (200 kg/a for Bintje and 220 kg/a and over for Ackersegen) – the crop mainly consisting of seed potatoes graded from 35 to 50 (55) mm – is able to compensate for the increase in yield which would have been obtained had the crop been allowed to ripen naturally and to realize in Class A a yield approximately equal or superior to that of Class B (26%).
But on day A this level of yield can only be obtained by pregermination of the seed, a process in which the appearance of potato haulm above the ground is accelerated by an average of 11 days and plant development hastened, the consequent increase in yield being 50–55 kg/a on day A.
The growth period of which the limited duration in Class A extends from the date of planting to that of early haulm destruction is generally the longest in a medium altitude zone (600–900 metres). It is shorter at both deep and high altitudes, in the former instance because of early appearance of the aphid vectors of virus

diseases, and in the latter on account of late planting. The most favourable zone is the intermediate one where production of seed potatoes of Class A reaches a yield approximately equal or superior to that of crops harvested at maturity (Class B).

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EXPERIMENTS ON THE USE OF ALCOHOL VAPOURS TO SUPPRESS THE SPROUTING OF STORED POTATOES [1])

W. G. BURTON

Ditton Laboratory, Department of Scientific and Industrial Research, Larkfield. Maidstone (Kent)

Summary in Eng., G. & Fr., p. 50

INTRODUCTION

The method commonly used to reduce the sprouting of stored potatoes by chemical means is to dust the tubers before storage with a solid sprout inhibitor [2] mixed with an inert filler. Solid inhibitors which have been used commercially include methyl α-naphthylacetate (GUTHRIE, 1939; VAN STUIVENBERG EN VELDSTRA, 1942), 2,3,5,6-tetrachlornitrobenzene (BROWN, 1947; LUCKWILL, 1949; BROWN AND REAVILL, 1954) and *iso*-propylphenylcarbamate (RHODES *et al.*, 1950). These inhibitors, although applied in the solid form, take effect in the vapour phase and thus are necessarily to some extent volatile. This slight volatility results in the active material being slowly lost during storage, which may mean that in potatoes stored until late in the season, the sprout depressant has been largely dissipated by the time it is most needed. This disadvantage can be overcome by increasing the rate of application of the inhibitor; by sorting and re-storing the potatoes in Spring and applying the inhibitor then; or by developing methods of introducing the inhibitor among the potatoes in store when it is required.

The first two of these methods increase the cost of treatment. The third has obvious advantages quite apart from the potentially more efficient sprout suppression – for instance the time of treatment can be adjusted to suit the variety stored and the season, and the farmer need not decide whether or not to go to the expense of employing a sprout inhibitor until some time after he has stored his potatoes, by which time he may be in a better position to know whether it is desirable to store some of his crop late. In the case of potato stores equipped with a power driven fan which can be used to ventilate the potatoes through ducts installed under them, it would appear possible to introduce the commonly used solid inhibitors in the air stream. This possibility is being explored in the Netherlands (OPHUIS, 1956). Alternatively the inhibitor may be introduced into the store atmosphere in the vapour phase.

In the case of solid inhibitors dusted on to the tubers, slow evaporation gives rise to an inhibitory concentration of the vapour in the film of still air surrounding each tuber and held in the interstices in the soil and applied dust on its surface. The inhi-

[1]) Received for publication 7 Dec. 1957.

[2]) The literature relating to this is extensive. The citations which follow are restricted to a few of the early original papers.

bitory concentration cannot extend far into the air space between tubers, in which there is a comparatively rapid convective air movement. If the dusting method were to be replaced by the introduction of the inhibitors in the vapour phase, an inhibitory concentration would have to be reached in the whole atmosphere of the potato stack, not only in the fraction of it in intimate contact with the tubers. The vapour would moreover have to be replenished at a rate sufficient to counteract its loss in the convective air currents. Such a vapour treatment, if applied in an ordinary farm store, would inevitably involve blowing a high proportion of the inhibiting vapour to waste. The introduction of expensive growth inhibiting substances in the vapour phase is thus too costly to be of commercial use, although there is no reason to believe that it would not be technically possible. MITCHELL AND MARTH (1947) reported the successful use of methyl α-naphthylacetate vapour to inhibit the sprouting of potatoes spread in a layer two or three tubers deep, the vapour being produced by heating the solid on a hot plate or stove. They stated that the vapour did not penetrate satisfactorily into piles or bins of potatoes, but it seems possible that this difficulty could be overcome by introducing the vapour into a sufficiently rapid stream of air ventilating the potatoes from below.

It is clear from the above that a growth inhibitor which is to be introduced in the vapour phase, and which is to be suitable for commercial application, must be cheap. In addition, the technical difficulty of controlling the concentration of the vapour of a solid inhibitor renders a gas or a readily vaporized liquid preferable. ELMER (1932) found that volatile substances evolved by ripening apples would inhibit the sprouting of potatoes, and HUELIN (1933) tested the effect upon sprout growth of the vapours of a number of substances present in apples. He found geraniol, citral, ethyl alcohol and acetaldehyde, in unspecified concentrations, to retard sprouting, and ethylene at a concentration of 0.01 per cent to cause marked though temporary sprout suppression. Attempts to use ethylene in field clamps showed no promise of commercially acceptable results (BARKER, 1934); it has however been used with success to inhibit sprout growth in potatoes stored at 45°F in sacks in a gas-tight store, in which the ventilation was sufficient to prevent the accumulation of carbon dioxide (FURLONG, 1948). BURTON (1952) found that the volatile substances, other than carbon dioxide, evolved by stored potatoes would inhibit their sprouting if allowed to accumulate, and, in the belief that the vapour of n-amyl alcohol might form an appreciable proportion of these volatiles (WEGNER, 1949) tested its effect upon sprout growth. It proved to be very effective, sprouting being inhibited at a concentration of 1 mg/l (BURTON, 1952). The vapours of a number of other alcohols were later found to possess suppressant properties (BURTON, 1956) the most effective of those tested being the vapour of nonyl alcohol (3-5-5-trimethylhexan-1-ol). It seemed possible that such vapours might be of use commercially, provided they could be distributed at the correct concentration throughout a large mass of potatoes. Experiments to assess the practicability of commercial use were therefore begun in 1951 and are described below.

METHODS

The initial large scale experiments were done on bulks of 15–16 metric tons of potatoes stored in a straw-bale enclosure in a corrugated iron shed. Treatments which were successful on this scale were then repeated on greater bulks, up to 165 metric tons. The vapours were introduced into an air stream which was blown through the potatoes from below, being fed either under a slatted false floor underlying the potatoes, or into ducts underneath them, spaced at not more than 1.8 m between centres. Introduction of the vapour into the air stream was by means of evaporation from wicks or towelling dipping into a container of the alcohol at the delivery end of the fan. Such a method is very simple but the concentration of vapour cannot readily be adjusted except by a process of trial and error. The concentration of the vapour was determined by measuring the rate of alcohol consumption and the rate of air delivery from the fan. The rate of evaporation, and hence the concentration, was of course affected by the temperature of the ventilating air – a further drawback to the use of wicks as a means of introducing the vapour commercially. A unit for vapour introduction has since been designed by a commercial firm, and consists of an adjustable drip-feed on to a small hot plate at the fan intake. The alcohols used in our experiments were commercial amyl and nonyl alcohols, the first being a variable mixture of *iso*-amyl alcohol (3-3-dimethylpropan-1-ol) and active amyl alcohol (2-methylbutan-1-ol); while the second was about 95 % 3-5-5-trimethylhexan-1-ol, together with small amounts of the 3,4,5 the 4,5,5 and the 3,4,4 trimethyl hexanols.

Amyl alcohol vapour will completely inhibit sprout growth at 10°C if present in the air at a concentration of 1 mg/l, and growth is very slight if the concentration is as low as 0.2 mg/l. In our large scale experiments we therefore aimed at obtaining a concentration of between 0.5 and 1 mg/l during periods when the weather was sufficiently warm for vigorous sprout growth to occur. It had been noticed, in laboratory experiments, that the effect of the amyl alcohol was persistent for about two weeks after the cessation of treatment. Apparently normal sprout growth then occurred. This persistence of the effect led to the adoption of a discontinuous method of treatment, as a means of conserving alcohol, in which a period of approximately two weeks' ventilation was followed by a similar period without treatment. This was not a rigid timetable. For instance the period without treatment was curtailed if signs of sprout growth were observed, while during cold weather the treatment was discontinued altogether.

The routine method adopted in all the experiments was to examine the potatoes in the top 20–30 cm of the stack once every week. When bud enlargement was observed, ventilation with the alcohol vapour was started and continued discontinuously as described above. Precisely the same methods were used with nonyl alcohol as with amyl alcohol. Nonyl alcohol vapour will completely inhibit sprout growth at 10°C if present in the air at a concentration of 0.1 mg/l and growth is very slight if the concentration is 0.02 mg/l.

In our large scale experiments we aimed at obtaining a concentration just one tenth that attempted in the case of the amyl alcohol vapour – i.e. between 0.05 and 0.1 mg/l.

Controls of untreated potatoes were included in the smaller scale experiments, but in the work on a real commercial scale they were omitted. The reason for this was that if they had been of the same size as the experimental stacks, the experiments would have been too large to handle with the resources and facilities available; while if they had been much less than the experimental stacks they would have had little value as controls – the temperature conditions for instance would have been entirely different.

RESULTS

The experiments which have been undertaken and the results so far obtained are described in chronological order.

1951–52 (Amyl alcohol)

Weight of potatoes:	15–16 metric tons, variety Majestic.
Method of storage:	To a depth of 1.8 metres on a false floor in a straw bale enclosure 3.6 × 3.6 m in the corrugated iron store described by WAGER *et al.* (1952).
Method and rate of ventilation:	15-cm axial flow type electric fan delivering 1130 litres per minute, i.e. c. 70 litres per minute per 1000 kg stored.
Concentration of vapour:	Average in any one period of treatment varied from 0.28 to 0.83 mg/l depending upon the temperature of the ventilating air.
Period of storage:	3/10/51–26/5/52. (The dates given are those of the commencement of loading and unloading respectively).
Range of mean temperature of the potatoes during storage (weekly average):	3.2–10.8 °C.
Control:	A similar tonnage stored in an enclosure of the same dimensions in another building and maintained at a closely similar temperature (normally within ± 0.5 °C).
Sprout growth:	Treated: negligible in the bulk of the potatoes, but in the top 15 cm sprout growth varied from 2.2 to 4.8 % by weight. Average, 0.5 % by weight. Control: Varied from 3.4 % by weight in the centre to 8.6 % in the top 15 cm. Average, 5.0 %.

This experiment was very successful and showed the practicability of the method in principle. Since much of the alcohol blew to waste it was thought that it might be possible to increase the tonnage treated without increasing either the rate of ventilation or the consumption of alcohol. Also, since the bulk of the potatoes stored in England were stored in clamps in the field or in stores with no facilities for ventilation, it was thought advisable to determine whether it would be possible to make use of natural convective circulation as a means of introducing the vapour. These were therefore the objectives of our work in 1952–53.

1952–53 (Amyl alcohol)

(a) Using a similar apparatus for introducing the vapour as in the previous experiment, arrangements were made to treat about 100 tons of Majestic potatoes on a farm near Canterbury. Unfortunately the grower sold the crop early in 1953 before any conclusive results had been obtained.

(b) Again using a similar apparatus, arrangements were made (through the good offices of DR. A. R. WILSON of the Agricultural Research Council's Potato Storage Investigation Team) to treat about 95 tons of King Edward potatoes on a farm near Bingham, Notts. The running of the experiment was largely undertaken by DR. WILSON and MR. P. T. G. TWISS of the same team. By the time the arrangements had been made sprout growth had already occurred to some extent. The experiment was

unsuccessful – sprout suppression was confined to regions close to the ducts – but it was thought that this might be due to the late start of the treatment.
(c) In order to test the possibility of making use of natural convective circulation containers of amyl alcohol provided with wicks were placed in each of two open-ended ducts under 15–16 metric tons of potatoes stored in the same enclosure as in 1951–52. The evaporation of the alcohol was of the right order of magnitude, but distribution through the potatoes did not follow the expected pattern. On occasions the direction of air flow was not into the ducts and up through the potatoes, but was out from the ducts. The treatment was thus unsuccessful.
(d) An unsuccessful attempt was made to use the method in a field clamp. Containers of amyl alcohol were placed along the centre line of the clamp at intervals of 1.8 m. Wicks dipped into the alcohol and each apparatus was enclosed in a wooden box with slatted sides. It could be refilled by means of a pipe leading to the outside of the clamp. There was some suppression of sprout growth immediately in the vicinity of each apparatus but there was obviously little distribution of the vapour throughout the clamp and the results gave little promise of successful results being obtained by this method.

As a result of the experiments in 1952–53 it was concluded that no useful purpose would be attained by continuing our attempts to introduce alcohol vapours by convection – particularly as our work in a related field was devoted to investigating and advocating the storage of potatoes in buildings equipped with facilities for forced draught ventilation. It also seemed uncertain whether attempts to introduce the vapours in a slow air stream would be successful in large bulks of potatoes, but it was decided to repeat this work the following year.

1953–54 (Amyl alcohol)

I am very grateful to W. A. May, Esq., of Hermitage Farm, Barming, Nr. Maidstone, for his co-operation in this experiment.

Weight of potatoes:	85–90 metric tons, variety Majestic.
Method of storage:	To a depth of 2.4 metres in a wooden bin 10.8 × 5.4 m in a brick built potato store.
Method and rate of ventilation:	15-cm axial flow type electric fan delivering 1130 litres per minute, i.e. c. 13 litres per minute per 1000 kg stored.
Concentration of vapour:	Average in any one period of treatment varied from 0.30 to 0.64 mg/l depending upon the temperature of the ventilating air.
Period of storage:	23/10/53–21/4/54. (The dates of commencement of loading and unloading respectively).
Range of maximum temperature of the potatoes during storage (weekly average):	4.9–16.3 °C.
Sprout growth:	Broadly speaking, sprouting was reduced to 0.2–0.5 per cent by weight in the bottom half of the stack, while it was 3–3.8 per cent throughout the top half.

It seemed clear from this experiment that commercially acceptable suppression of sprout growth could not be attained unless the rate of ventilation was raised considerably above the 13 litres per minute per 1000 kg – probably to the level used in the successful experiment in 1951–52, viz. 70 litres per minute per 1000 kg. This meant that commercial amyl alcohol was too expensive in use to provide an economically attractive alternative to other methods of sprout suppression. The use of nonyl alcohol was therefore investigated on the small scale and later tried on the large scale.

1955–56 (Nonyl alcohol)

Weight of potatoes:	15–16 metric tons, variety Dr. McIntosh.
Method of storage:	As in 1951–52.

Method and rate of ventilation:	15-cm centrifugal fan delivering 1600 litres per minute, i.e. 100 litres per minute per 1000 kg stored.
Concentration of vapour:	Average in any one period of treatment varied from 0.04 to 0.12 mg/l depending upon the temperature of the ventilating air.
Period of storage:	25/10/55 to 23/5/56. (The dates of commencement of loading and unloading respectively).
Control:	1000 kg stored in a small straw bale enclosure at one side of the main enclosure.
Sprout growth:	Treated: Negligible, except in a small part of the stack where a lot of earth was present. Average, 0.2 % by weight. Control: Average, 3.3 % by weight.

This experiment showed the practicability of using nonyl alcohol vapour at a very low concentration to suppress the sprouting of potatoes stored in bulk, provided the rate of ventilation was of the order of 100 litres per minute per 1000 kg of potatoes. It remained to be shown whether the distribution of vapour would be sufficiently uniform on the commercial scale.

1956–57 (Nonyl alcohol)

(a) This experiment was made possible through the co-operation of DR. A. R. WILSON, in charge of the Agricultural Research Council's Potato Storage Investigation Team at Sutton Bonington. The day-to-day running of the experiment was undertaken by MR. P. T. G. TWISS of the above team.

Weight of potatoes:	160–165 metric tons, variety King Edward.
Method of storage:	To a depth of 3 metres in a brick built potato store measuring 17 × 5.2 metres. There was a sunken central ventilating duct with slatted wooden lateral ducts fed from it and spaced at 1.5 m between centres.
Method and rate of ventilation:	Centrifugal fan delivering 17,000 litres per minute, i.e. of the order of 100 litres per 1000 kg stored. Following a breakdown this fan was replaced by an axial flow type delivering the same quantity of air.
Concentration of vapour:	There was some difficulty in achieving a sufficiently high concentration of the vapour, but after modifications to the number and arrangement of the wicks an average concentration of about 0.05 mg/l was obtained.
Period of storage:	9/10/56 to 20/5/57. (The dates of commencement of loading and unloading respectively).
Range of maximum temperature of the potatoes during storage (weekly average):	7.2–15.2°C.
Sprout growth:	Prior to a sufficiently high concentration of the vapour being obtained there was a certain amount of sprout growth. After raising the concentration to 0.05 mg/l there was no further growth and the sprouts already formed were killed. As in 1955–56 sprout growth was not suppressed where a lot of earth was present. Average, based on 27 samples of 10 kg, 0.41 per cent by weight.

This experiment clearly showed that ventilation with alcohol vapours could be used to suppress sprout growth on the commercial scale. It also showed that it was essential to start introducing the vapour at an inhibitory concentration immediately signs of sprout growth were observed. Delay, as in this case, until some sprouts – mainly on the top surface – had grown to a length of about 5 cm led to the death of these sprouts and some damage to the tuber tissue round the base of the sprout. In most cases this was too slight to affect the saleability of the potatoes, but it was sufficiently serious in some tubers to lead to an average of 0.53 % by weight being discarded. There was no evidence that this

damage had led to any serious rotting – all rotted tubers examined were found to be associated with *Phytophthora* infection or mechanical injury – but there is clearly a potential danger of rotting if such damage is caused. At the bottom of the stack where the concentration of vapour might have been expected to be at its highest, but where early sprout growth would be less advanced because of the lower temperature, the number of tubers with even slight damage was very small.

(b) The treatment was applied to about 90 metric tons of potatoes stored in a barn by MR. F. H. VILLIERS, Superintendent of Field Experiments at East Malling Research Station. The vapour was introduced through 10-cm asbestos drain pipes running the length of the stack underneath the potatoes and about 1.5 metres apart. 1.25 cm holes were drilled in the pipes at intervals of 45 cm. The concentration of the vapour was about 0.12 mg/l and the rate of ventilation about 5,700 litres per minute, i.e. about 63 litres per minute per 1000 kg stored. Sprouting was negligible when the potatoes were unloaded in May.

DISCUSSION

a. The technical side

It is clear from the above experiments that satisfactory sprout suppression can be attained on the commercial scale, by the use of alcohols, provided the vapours are introduced in an air stream of sufficient magnitude. The reasons for this necessity were not appreciated in our earlier work, which was done before calculations of the volume of air entering a potato stack by convection showed that this might be about 130–190 litres per minute per 1000 kg (BURTON *et al.*, 1955).

This is the approximate volume of air concerned in the removal of metabolic heat when a state of dynamic thermal equilibrium is established in an unventilated potato stack. If, therefore, the rate of ventilation in the course of introducing the alcohol vapour falls below some 150 litres per minute per 1000 kg, one must expect sufficient air to be drawn in by convection, through the top surface of the stack, to bring the total volume of air entering it up to this value of 150 litres. The vapour is thus diluted, and, if the degree of dilution is great, the concentration may fall so low that it is ineffective.

The dilution will not be uniform, but will be greatest near the region of entry of the convective air – i.e. in the upper part of the stack. Thus in the first experiment, in 1951–52, in which the rate of ventilation was 70 litres per minute per 1000 kg, there must have been an approximately equal amount of air drawn into the stack by convection. The vapour was thus diluted, but not sufficiently to render it ineffective in the bulk of the stack, where very good control of sprouting was achieved. At the very top of the stack, however, the dilution was sufficiently serious for the sprout growth to amount to approximately half that in a similar position in the control stack.

Similarly, in the 1953–54 experiment, when the rate of ventilation was only 13 litres per minute per 1000 kg, one would expect that about ten times this amount of air must have been drawn into the stack by convection. The resultant dilution of the alcohol vapour prevented any acceptable suppression of sprouting in the upper half of the stack, though even in this case the suppression in the lower half of the stack was marked.

In the experiment in 1952–53 at Bingham the rate of ventilation was slightly lower –

12 litres per minute – and in this case sprouting was apparently unaffected by the treatment in the bulk of the potatoes but was suppressed to an appreciable extent over the ducts, particularly near the points of entry of the vapour. The experiments with amyl alcohol, therefore, provide a series of examples of the effects of progressively serious dilution of the vapour with air drawn in by convection, ranging from dilution which scarcely impaired the effectiveness of the treatment (when the rate of ventilation was 70 litres per minute per 1000 kg) to dilution which was so serious as to render the effects of the treatment quite negligible in the bulk of the potatoes (when the rate of ventilation was 12 litres per minute per 1000 kg). To blow air containing an inhibitory concentration of amyl alcohol through potatoes at 70 litres or more per minute per 1000 kg would be too expensive for ordinary commercial use.

Nonyl alcohol is both cheaper than amyl alcohol and effective at about a tenth the concentration, and thus its use is economically feasible at these rates of ventilation. In 1955–56 and in the main experiment in 1956–57, when the rate of ventilation was 100 litres per minute per 1000 kg, the dilution would be slight, and insufficient to reduce the effectiveness of sprout inhibition. In the other case in 1956–57 the dilution must have been greater, but the initial concentration was comparatively high – about 0.12 mg/l – and thus the sprout inhibition was again satisfactory.

As a general principle, however, it would seem preferable to use an adequate rate of ventilation – say 100 to 150 litres per minute per 1000 kg – and a concentration of vapour no higher than necessary, rather than compensate for an inadequate rate of ventilation, and consequent dilution by convective air, by increasing the initial concentration of the vapour. To increase the rate of ventilation above about 150 litres per minute per 1000 kg would result in an unnecessary waste of alcohol.

b. The economical side

The cost of suppressing sprout growth by the use of alcohol vapours may be divided into three components: – The cost of the alcohol used; the cost of the electricity consumed; and the annual cost – i.e. depreciation and interest on capital – of the apparatus used for introducing the vapour.

At present prices in England the cost is approximately 4 shillings per 1000 kg calculated as follows:

Alcohol Assuming a concentration of 0.1 mg per l, a rate of ventilation of 100 litres per minute per 1000 kg and 15 days' treatment per month, the consumption of nonyl alcohol would be 215 g per 1000 kg of potatoes per month. The number of months in which treatment would be necessary would depend upon the variety, the storage conditions, and the length of storage. For potatoes stored until the end of May under conditions normally encountered in the south of England, about four monthstreatment should suffice, and the total alcohol consumption would be less than 900 g per 1000 kg potatoes. *The cost of this at present prices would be, in English money, about 3 shillings.*

Electricity The consumption during 60 days running time as suggested above would be about 2 kilowatt hours per 1000 kg.

The cost of this in the south of England would be about 0.18 shillings per 1000 kg.

Apparatus. A commercial apparatus employing a hot plate and capable of treating 300 metric tons costs at present prices about £ 75. Allowing 10 % p.a. depreciation and 5 % interest on capital, the annual charge of this would be 0.75 shillings per 1000 kg if the apparatus were used to capacity.

In addition to being efficient and cheap a sprout inhibitor must not impair the quality of the potatoes. No adverse effects on cooking quality have been noticed after treatment with nonyl alcohol vapour, but it is advisable to stop the treatment one or two weeks before marketing the potatoes. The smell of the alcohol, which normally adheres to them in store, disappears during grading and distribution.

The use of alcohol vapours to suppress sprouting should not be allowed to interfere with normal good storage practices. For instance the installation of the apparatus for introducing the vapour into the duct system under the potatoes should be done in such a way that the ducts can still be used, when the apparatus is not in use, for their primary purpose of cooling the stack. When the apparatus is in use, of course, all other entries to the duct system must be closed.

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SUMMARY

EXPERIMENTS ON THE USE OF ALCOHOL VAPOURS TO SUPPRESS THE SPROUTING OF STORED POTATOES

The suppression of sprouting in stored potatoes by ventilating them with growth inhibiting vapours offers several advantages over the usual dusting methods. It is essential that the rate of ventilation with the air stream containing the vapour should be sufficiently rapid to prevent excessive dilution of the vapour with convective air. A rate of 100 to 150 litres per minute per 1000 kg of potatoes is suggested. To increase the rate above 150 litres per minute per 1000 kg is wasteful.

Nonyl alcohol vapour at a concentration of 0.05 to 0.12 mg per litre of ventilating air has prevented sprout growth in bulks up to 165 metric tons without impairing the cooking quality of the potatoes.

The total cost of such a method in commercial use would be about 4 shillings (English money) per 1000 kg. It is essential that the treatment should be started as soon as the first signs of bud enlargement are observed on the potatoes on the top of the stack. Delay until the sprouts are an appreciable size may result in damage to the tubers with a potential danger of rotting.

ZUSAMMENFASSUNG

UNTERSUCHUNGEN ÜBER DIE VERWENDUNG VON ALKOHOLDÄMPFEN ALS MITTEL DER HEMMUNG DER SPROSSENBILDUNG VON GELAGERTEN KARTOFFELN

Die Keimungsunterdrückung gelagerter Kartoffeln durch Ventilierung mit wachstumshemmenden gasförmigen Stoffen zeigt verschiedene Vorteile im Vergleich zu den üblichen Stäubemethoden. Es ist wesentlich, dass die Geschwindigkeit des Ventilationsstromes, der die Gase enthält, gross genug ist, um übermässige Verdünnung dieser Gase mit Konvektionsluft zu verhindern. Eine Geschwindigkeit von 100 bis 150 l je Minute je 1000 kg is wünschenswert. Eine Erhöhung dieser Geschwindigkeit über 150 l je Minute je 1000 kg ist Verschwendung.

Nonylalkohol-Dämpfe in Konzentrationen von 0.05 bis 0.12 mg je Liter Ventilationsluft verhindern Sprossung in Lagerungen bis zu 165 Tonnen ohne Verminderung der Kochqualität der Kartoffeln. Die Gesamtkosten einer solchen Behandlung auf kommerzieller Basis wären bei den zurzeit geltenden Preisen ungefähr 4 Shillinge (Englisches Geld) je 1000 kg.

Es ist wesentlich, mit der Behandlung zu beginnen sobald die ersten Anzeichen von Knospenschwellung an den Kartoffeln zu oberst im Lagervorrat beobachtet werden. Eine Verzöge-

rung der Behandlung, bis die Sprossen eine ansehnliche Grösse erreicht haben, kann zur Beschädigung der Knollen führen und bringt die Gefahr der Fäule mit sich.

RÉSUMÉ

RECHERCHES SUR L'UTILISATION DE VAPEURS ALCOOLIQUES POUR REDUIRE LA GERMINATION DE POMMES DE TERRE STOCKÉES

La répression de la germination de pommes de terre entreposées par aération à l'aide de retardateurs de croissance gazeux présente plusieurs avantages en comparaison des méthodes àb ase de poudre généralement appliquées. Il importe que la rapidité du courant d'aération dans lequel sont contenus les gaz, soit assez grande afin d'éviter une dilution excessive de ces gaz avec des courants de convection. Une rapidité de 100 à 150 litres par minute par 1000 kg paraît recommandable. Une augmentation de cette vitesse dépassant les 150 litres par minute par 1000 kg serait du gaspillage pur.

Des vapeurs d'alcool nonylique, introduits en concentrations de 0,05 à 0,12 mg par litre d'air d'aération empêchent la formation de pousses dans des unités de stockage de 165 tonnes au maximum, sans détorier la qualité culinaire des pommes de terre à la cuisson. Le total des frais d'un traitement pareil à base commerciale se chiffrait devant les prix actuellement en vigueur à environ 4 sh (monnaie anglaise) par 1000 kg.

Les stocks doivent être traités, sitôt que s'annoncent les premiers indices de grossissement des boutons des pommes de terre logées dans les couches supérieures du tas. Lorsqu'on traite les pousses au moment où elles ont déjà atteint une grosseur appréciable, on risque d'avarier les tubercules, ce qui rendra le danger du pourriture beaucoup plus grave.

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CONTROL OF *RHIZOCTONIA SOLANI* KÜHN IN POTATOES BY DISINFECTION OF SEED TUBERS AND BY CHEMICAL TREATMENT OF THE SOIL[1]

J. H. VAN EMDEN
Instituut voor Plantenziektenkundig Onderzoek, Wageningen, Netherlands

Summary in Eng., G. & Fr., p. 62

INTRODUCTION

The effect of *Rhizoctonia solani* KÜHN on the potato plant is greatly influenced by environmental conditions. In some cases its presence is only apparent through the occurrence of sclerotia on the tubers; in other cases, however, the sprouts may be affected before they emerge from the soil and the plant may be killed altogether. Between these two extremes there are many intermediate degrees of attack. This far reaching influence of environment makes it impossible to predict to what extent the disease will manifest itself in a particular field and thus, to what extent control measures will show effect.

The inoculum of the fungus may be carried on the seed tuber as sclerotia and as mycelium, often to be found in the cavities around the eyes, but may also be present in the soil. Hence, control may be attempted either by seed tuber disinfection or by soil treatment and it is to be expected that control measures aimed at eliminating both sources of infection will be the most effective.

In the present paper we shall discuss the results of experiments in which seed disinfection and soil treatment were applied separately as well as combined. Although the importance of soil, weather conditions and cultural measures is fully appreciated, these are not dealt with in the present paper. Since these experiments were carried out in seed potato growing areas, the effect on the incidence of sclerotia in the crop was used as the main criterion to compare treatments. Yields were also taken, but the small size of the plots does not permit an accurate estimate of the effect on yield of the control measures.

However, the figures obtained suffice to give an indication as to the possible effect on crop size. All experiments were laid out in such a manner as to permit statistical analysis of the results. In order to arrive at an estimate of the amount of black scurf occurring in each plot, a sample of about 5 kg was taken and each tuber classified according to the amount of scurf present. From the weight of the tubers in each class a single figure for the sample was calculated. This method, although laborious, was

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found to be practicable and the figures obtained lent themselves well to statistical computation. For presentation of the experimental results in this paper we have, however, chosen to state for each treatment the weight of clean tubers expressed as a percentage of total sample weight.

Disinfection of seed potatoes was tried in 1916 by QUANJER (1916), using mercuric chloride at a dilution of 1:15,000. The tubers were submerged in the solution for 90 minutes. The experiment was carried out in three localities, in one of which the soil was heavily infested with *Rhizoctonia*. In this latter case the treatment did not result in a cleaner crop, but in the other two the appearance of the harvested tubers was much improved.
In 1918 seed disinfection by soaking the tubers for 90 minutes in a 1:10,000 solution of mercuric chloride was tentatively recommended to a number of seed potato-growers by DORST (1920). In some cases an increased yield was obtained, in other cases yield was not found to be influenced and sometimes yield was slightly depressed. The majority of growers, however, reported that the crop obtained from disinfected seed was much cleaner in appearance and more evenly sized.
Abroad, seed disinfection with mercuric chloride was also succesfully tried by CUNNINGHAM (1925), DANA (1925) and STÖRMER (1938).
Although seed disinfection with mercuric chloride and later with organo-mercury compounds became very popular for a time amongst growers of seed potatoes in certain districts in Holland, the practice was later virtually abandoned.
A tentative explanation of this may be that the sclerotia of *R. solani* do not become very conspicuous until towards the end of the growing season and if the crop is lifted early, as was done in later years for the purpose of viruscontrol, it always appears much cleaner than when it has been left in the soil for a longer period. It is also possible, that due to the practice of disinfecting the seed tubers, the level of incidence of the disease was reduced to an extent which led the growers to consider seed disinfection an unnecessary complication of their routine.
Soil treatment with mercury compounds for control of *R. solani* in potatoes was experimented on by MARTIN (1931), VAN DER SLIKKE (1935) and STÖRMER (1938). HOOKER (1935) used pentachloronitrobenzene. Although these authors all obtained favourable results, their methods were not adopted by the growers.
Gradually *R. solani* has again become a serious problem, especially for the growers of seed potatoes who have to comply with stringent regulations of importing countries. Hence it was decided to reinvestigate the effect of seed disinfection as well as the effect of soil treatment for the purpose of *Rhizoctonia* control.

EXPERIMENTAL

Effect of seed treatment and time of lifting. In 1954 a small experiment was planted in which the effect of seed treatment and time of lifting on the incidence of sclerotia was studied. The results are given in Table 1.

TABLE 1. Effect of seed tuber disinfection with an organo-mercury compound and time of lifting on the incidence of sclerotia on the crop

Variety	Treatment of seed	% clean tubers by weight	
		Lifted green	Lifted 24 days after haulm killing
Bintje	Disinfected *(desinfiziert)*	96	92
Eersteling	Disinfected *(desinfiziert)*	95	90
Bintje	Untreated *(Unbehandelt)*	91	79
Eersteling	Untreated *(Unbehandelt)*	91	61
Sorte	*Behandlung der Saatknollen*	*Grün gerodet*	*24 Tage nach der Krauttötung gerodet*
		Gewichtsprozente reiner Knollen	

TABELLE 1. *Wirkung der Saatkartoffeldesinfektion mittels organischer Quecksilberverbindung und Einfluss des Rodungszeitpunkts auf den Sklerotienbefall der Ernte*

These figures show, that if the crop was lifted green, there was little difference in the incidence of sclerotia. If the crop was left in the soil for 24 days after haulm killing, the difference was much greater.

The effect of disinfection of the soil, absence or presence of sclerotia in the tubers and seed disinfection. In 1955 two factorial experiments were carried out. The treatments were (a) disinfection of the soil, (b) absence or presence of sclerotia on the tubers and (c) seed disinfection.

In one experiment two soil treatments were tried; pentachloronitrobenzene at 200 kg/ha and zineb at 13 kg/ha. Seed disinfection was done in November with an organo-mercury compound. The results of these experiments are given in Table 2, p. 55.

In these experiments the treatments 010, 110 and 210 show a considerably lower percentage of clean tubers than the treatments 011, 111 and 211. This indicates that disinfection of seed tubers bearing sclerotia was very effective in reducing the incidence of sclerotia on the crop. Disinfection of apparently clean seed tubers also resulted in a cleaner crop as may be seen from a comparison of the treatments 000, 100 and 200 on one hand and treatments 001, 101 and 201 on the other. Comparison of treatments 001, 101 and 201 with treatments 011, 111 and 211 shows that clean seed tubers when disinfected give a cleaner crop than do sclerotia bearing tubers when disinfected. This indicates that the seed treatment carried out was not powerful enough to kill the inoculum on the sclerotia bearing tubers quantitatively. In neither experiment did the soil treatment result in a cleaner crop, probably because the application was made intentionally as late as feasible, viz. six weeks after planting, when the field was harrowed for the last time.

In both experiments treatments 010, 110 and 210 gave the lowest yield, these treat-

TABLE 2. Effect of soil treatment, occurrence of sclerotia on the seed tuber and seed disinfection on the incidence of sclerotia on the crop

Code	Experiment 1955 (1)		Experiment 1955 (2)	
abc	% clean tubers by weight	Yield in g/plant	% clean tubers by weight	Yield in g/plant
000	42	677	51	525
001	72	671	75	489
010	15	547	3	430
011	62	622	35	542
100	53	666		
101	60	703		
110	21	560		
111	75	667		
200	57	627	54	497
201	73	617	69	481
210	17	509	2	428
211	57	617	39	506
abc	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*
Code	*Versuch 1955 (1)*		*Versuch 1955 (2)*	

TABELLE 2. *Ergebnis der Bodenbehandlung, Vorkommen von Sklerotien auf den Saatkartoffeln und Wirkung der Saatkartoffeldesinfektion auf den Sklerotienbefall der Ernte*

Significance of data on occurrence of *Rhizoctonia* in the crop

Experiment 1955 (1) *Versuch 1955 (1)*
F (a) = 1 F (0.05) = 3.5
F (b) = 7.94 F (0.05) = 4.4
F (c) = 25.29 F (0.01) = 8.2

Sicherheit der Daten betreffs das Vorkommen von Rhizoctonia in der Ernte

Experiment 1955 (2) *Versuch 1955 (2)*
F (a) = 1 F (0.05) = 4.6
F (b) = 78 F (0.01) = 8.9
F (c) = 26 F (0.01) = 8.9

Explanation of code
(a) 0 soil not treated
1 soil treated with zineb 13 kg/ha
2 soil treated with PCNB 200 kg/ha
(b) 0 seed tubers free from sclerotia
1 seed tubers with sclerotia
(c) 0 seed not treated
1 seed disinfected with organo-mercury compound[1]

Erklärung des Code
(a) 0 *nichtbehandelter Boden*
1 *Boden, behandelt mit Zineb 13 kg/ha*
2 *Boden, behandelt mit PCNB 200 kg/ha*
(b) 0 *Saatkartoffeln sklerotienfrei*
1 *Saatkartoffeln mit Sklerotien behaftet*
(c) 0 *Saatkartoffeln nicht behandelt*
1 *Saatkartoffeln desinfiziert mittels organischer Quecksilberverbindung*[1]

[1] The organo-mercury compound used in these experiments is a proprietary product, the active ingredient of which is known to the author.

[1] *Die bei diesen Versuchen zur Verwendung gelangte organische Quecksilberverbindung ist ein patentamtlich geschütztes Produkt, dessen aktivwirkender Bestandteil dem Autor bekannt ist.*

ments being those for which sclerotia bearing tubers were used without previous disinfection. When the crop from the experimental plots was graded according to size, it was found that these same treatments had produced more tubers larger than 45 mm than any of the other treatments. Since tubers of over 45 mm are not acceptable as seed, this is an additional reason for seed disinfection. This effect on size may be explained by the fact that the plants in the plots grown from disinfected seed had developed more stems than the plants grown from untreated seed, as is shown in Table 3.

TABLE 3. Influence of seed disinfection on tuber size and on the number of stems per plant

Treatment	Percentage of the crop in the size brackets				Average number of stems/plant	*Behandlung*
	< 28 mm	28–35 mm	35–45 mm	> 45 mm		
clean seed untreated	8.8	41.9	42.5	3.7	11.8	*reines Saatgut unbehandelt*
clean seed disinfected	9.3	44.7	44.6	1.4	13.6	*reines Saatgut desinfiziert*
seed with sclerotia untreated	8.2	30.3	46.8	14.7	8.2	*Saatgut mit Sklerotien unbehandelt*
seed with sclerotia disinfected	10.4	44.1	44.0	2.1	10.5	*Saatgut mit Sklerotien desinfiziert*
	Prozentsatz der Ernte nach Grössenklasse				*Mittelzahl der Stengel je Pflanze*	
	< 28 mm	28–35 mm	35–45 mm	> 45 mm		
	F = 13.7 F (0.01) = 8.2				F = 8.05 F (0.05) = 4.4	

TABELLE 3. *Einfluss der Saatkartoffeldesinfektion auf die Grösse der Kartoffelknollen und auf die Zahl der Krautstengel je Pflanze*

Apart from these two factorial experiments, a block experiment was planted in which soil treatment was applied at the time of planting. The results are given in Table 4.

TABLE 4. Influence of soil disinfection on the occurrence of sclerotia in the crop

Treatment	% of clean tubers by weight	Yield in grams/plant
Zineb 13 kg/ha	12	716
Zineb 27 kg/ha	22	716
PCNB 200 kg/ha	76	658
Untreated	18	674
Behandlung	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*
	F = 37.6 F (0.01) = 9.8	

TABELLE 4. *Einfluss der Bodenbehandlung auf das Vorkommen von Sklerotien in der Ernte*

These figures show that zineb had no effect on the appearance of the crop. The increased yield is probably due to a nutritional effect. PCNB greatly increased the percentage of clean tubers in the crop but appears to have caused a slight reduction of yield.

The effect of soil treatment with PCNB at a low rate (100 kg/ha)

In 1956 another experiment was carried out. Zineb was not used any more, but instead PCNB was tried at a lower rate. The incidence of *Rhizoctonia* was generally at a lower level in 1956 than it had been in 1955 as may be seen from the results of the 1956 experiment given in Table 5.

TABLE 5. Influence of seed disinfection and soil treatment on appearance of crop and on yield

Treatment code abc	% clean tubers by weight	Yield in g/plant
000	87	700
001	88	725
010	57	700
011	86	665
100	94	620
101	93	660
110	88	615
111	94	545
200	94	685
201	99	560
210	97	570
211	95	625
abc Code Behandlung	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*

TABELLE 5. *Einfluss der Saatkartoffeldesinfektion und der Bodenbehandlung auf das Auflaufen der Kartoffelpflanzen und auf den Ernteertrag*

Statistical significance of data on occurrence of *Rhizoctonia*
F (a) = 4.43
F (b) = 2.60
F (c) = 2.89

Sicherheit der Daten betreffs das Vorkommen von Rhizoctonia
F (0.05) = 3.5
F (0.05) = 4.4
F (0.05) = 4.4

Explanation of code:
(a) 0 soil not treated
1 soil treated with PCNB 100 kg/ha
2 soil treated with PCNB 200 kg/ha
(b) 0 seed tubers free from sclerotia
1 seed tubers with sclerotia
(c) 0 seed not treated
1 seed disinfected with organo-mercury compound

Erklärung des Code:
(a) 0 *nichtbehandelter Boden*
1 *Boden, behandelt mit PCNB 100 kg/ha*
2 *Boden, behandelt mit PCNB 200 kg/ha*
(b) 0 *Saatkartoffeln sklerotienfrei*
1 *Saatkartoffeln mit Sklerotien behaftet*
(c) 0 *Saatkartoffeln nicht behandelt*
1 *Saatkartoffeln desinfiziert mittels organischer Quecksilberverbindung*

TABLE 6. Influence of seed disinfection and soil treatment with PCNB at different times of application on appearance of crop and on yield

Treatment code abc	% clean tubers by weight	Yield in g/plant
000	38	586
001	75	631
002	55	556
010	11	607
011	56	601
012	36	554
100	35	622
101	72	601
102	55	633
110	10	528
111	58	633
112	29	532
200	60	647
201	76	612
202	73	573
210	38	594
211	80	617
212	57	615
abc Code Behandlung	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*

TABELLE 6. *Einfluss der Saatkartoffeldesinfektion und der Bodenbehandlung mit PCNB zu verschiedenen Anwendungszeiten auf das Auflaufen der Kartoffelpflanzen und auf den Ernteertrag*

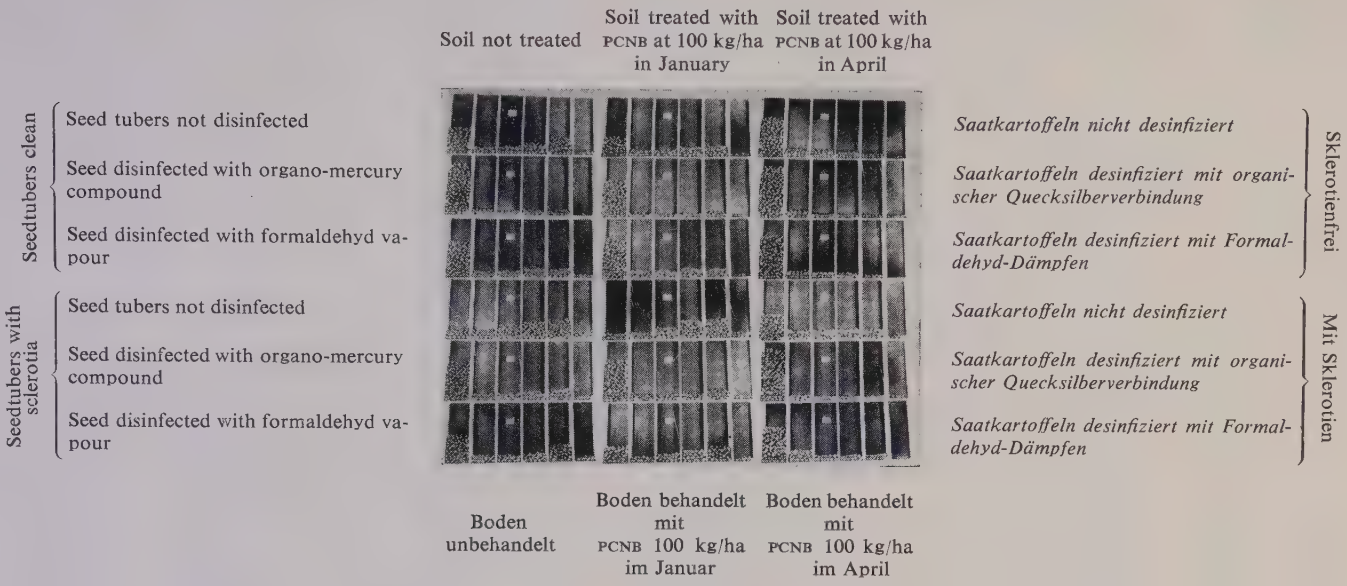
Statistical significance of data on occurrence of *Rhizoctonia* in crop
F (a) = 24.40
F (b) = 16.01
F (c) = 31.95

Sicherheit der Daten betreffs das Vorkommen von Rhizoctonia in der Ernte
F (0.01) = 10.9
F (0.01) = 7.2
F (0.01) = 5.1

Explanation of code:
(a) 0 soil not treated
1 soil treated with PCNB 100 kg/ha in January
2 soil treated with PCNB 100 kg/ha in April
(b) 0 seed tubers free from sclerotia
1 seed tubers with sclerotia
(c) 0 no seed disinfection
1 seed disinfected with organo mercury compound
2 seed disinfected with formaldehyde vapour

Erklärung des Code:
(a) 0 *nichtbehandelter Boden*
1 *Boden, behandelt mit PCNB 100 kg/ha im Januar*
2 *Boden, behandelt mit PCNB 100 kg/ha im April*
(b) 0 *Saatkartoffeln sklerotienfrei*
1 *Saatkartoffeln mit Sklerotien behaftet*
(c) 0 *keine Saatkartoffeldesinfektion*
1 *Saatkartoffeln desinfiziert mittels organischer Quecksilberverbindung*
2 *Saatkartoffeln desinfiziert durch Formaldehyd-Dämpfen*

FIG. 1. The harvest of the 1957 *Rhizoctonia* control experiment (see table 6) graded according to the amount of black scurf occurring on the tubers



At left the clean tubers and at right the severely affected tubers
Links die reinen und rechts die stark befallenen Saatkartoffeln

FIG. 1. *Die Ernte des Rhizoctonia-bekämpfungsversuchs 1957 (siehe Tabelle 6) gruppiert nach der Stärke des Schorfbefalls auf den Knollen*

This experiment shows the lowest percentage of clean tubers for treatment 010 in which no soil treatment or seed disinfection was applied and for which tubers bearing sclerotia were used. Both soil treatments appear effective in improving the appearance of the crop but there was a significant depression of yield caused by the soil treatment with PCNB at both levels of application.

The effect of early application (January) of PCNB. Since PCNB had given good control of *Rhizoctonia* in two successive years it was decided to try whether the undesirable effect of delaying emergence might be eliminated by applying the chemical at an earlier date instead of doing so at the time of planting.
The following year (1957), therefore, a very early application (January) was made before ploughing. For comparison another treatment was included in which application was made at the time of planting by broadcasting the chemical over the plots immediately after setting the tubers. The results of the experiment are given in Table 6 and in Fig. 1.
These figures show that again the lowest percentage of clean tubers came from the treatments in which seed tubers bearing sclerotia were used without seed disinfection. Seed disinfection with organo-mercury compound was more effective than the treatment with formaldehyde-vapour. The early soil treatment, applied in January, was clearly ineffective. Probably the fungicide got too deeply buried by ploughing. The application of PCNB at 100 kg/ha immediately after planting significantly improved the appearance of the crop. Yield figures are erratic and no conclusions can be drawn from them. This is probably due to the fact that the field suffered from drought.

Some other observations
Apart from these experiments designed for the purpose of investigating the control of *R. Solani*, observations on the incidence of the disease were made in two more experiments designed primarily for investigating the control of common scab bij chemical treatment of the soil. The treatments used were PCNB at 60 kg/ha and at 90 kg/ha, mercuric chloride at 16 kg/ha and sulphur at 200 kg/ha. The results are given in Tables 7 and 8.

The figures in Table 7 show an overall decrease in the percentage of clean tubers between the two dates of lifting. This confirms the results obtained in 1954 with regard to the influence of time of lifting on the incidence of sclerotia (see Table 1).
Both Tables 7 and 8 show that PCNB and mercuric chloride were effective in reducing the incidence of sclerotia in the crop.

TABLE 7. Influence of soil treatment with PCNB, mercuric chloride and sulphur on the incidence of *R. solani*

Variety „Eigenheimer", seed not disinfected

Treatment	% clean tubers by weight		Yield in grams/plant	
	A[1]	B[1]	A[1]	B[1]
PCNB 60 kg/ha	69	47	632	877
PCNB 90 kg/ha	75	56	632	823
$HgCl_2$ 16 kg/ha	60	29	692	856
Sulphur 200 kg/ha . . .	20	1	695	876
Control untreated . . .	10	0	657	831
Behandlung	*Gewichtsprozente reiner Knollen*		*Ertrag in Gramm je Pflanze*	

TABELLE 7. *Einfluss der Bodenbehandlung mit PCNB, Quecksilberchlorid und Schwefel auf das Vorkommen von Rhizoctonia solani*

Sorte „Eigenheimer", Saatkartoffeln nicht desinfiziert

Significance of data on occurrence of *Rhizoctonia*
F (soil treatment) = 30.4 for crop lifted 29/7
F (soil treatment) = 26.4 for crop lifted 9/9
F (0.01) = 9.8

Sicherheit der Daten betreffs das Vorkommen von Rhizoctonia
F *(Bodenbehandlung) = 30.4 für Ernte gerodet am 29/7*
F *(Bodenbehandlung) = 26.4 für Ernte gerodet am 9/9*
F (0.01) = 9.8

[1] A = Lifted 29/7 after haulm killing 19/7.
B = Lifted 9/9 after haulm killing 29/7.

A = *Gerodet 29/7 nach Krauttötung 19/7.*
B = *Gerodet 9/9 nach Krauttötung 29/7.*

TABLE 8. Influence of soil treatment with PCNB, mercuric chloride and sulphur on the incidence of *R. solani*

Variety „Noordeling", seed not disinfected

Treatment	% clean tubers by weight	Yield in grams/plant
PCNB 60 kg/ha	87	579
PCNB 90 kg/ha	93	546
$HgCl_2$ 16 kg/ha	96	553
Sulphur 200 kg/ha	71	596
Control untreated	50	573
Behandlung	*Gewichtsprozente reiner Knollen*	*Ertrag in Gramm je Pflanze*

TABELLE 8. *Einfluss der Bodenbehandlung mit PCNB, Quecksilberchlorid und Schwefel auf das Vorkommen von R. solani*

Sorte „Noordeling", Saatkartoffeln nicht desinfiziert

Significance of data on incidence of *Rhizoctonia*
F (soil treatment) = 10.98
F (0.01) = 9.8

Sicherheit der Daten betreffs das Vorkommen von Rhizoctonia
F *(Bodenbehandlung) = 10.98*
F *(0.01) = 9.8*

DISCUSSION AND CONCLUSIONS

In four years of experiments on the control of *R. solani* it was found that disinfection of seed tubers may considerably reduce the incidence of sclerotia on the crop. This effect may be produced, even if the seed tubers appear to be free from sclerotia as mycelial threads of the fungus may be present in the cavities around the eyes.

In all experiments it was found that even if disinfection is practised, clean seed tubers produce a cleaner crop than sclerotia-bearing tubers. This indicates that the methods of disinfection used did not kill the fungus inoculum quantitatively. Testing of sclerotia removed from disinfected seed tubers, by incubation on water-agar for four days at 20°C, showed that about 20 per cent were still capable of germinating. Mycelial growth from sclerotia removed from treated tubers was, however, slow as compared to that from untreated sclerotia. Apparently, however, even an incomplete disinfection of seed tubers may suffice to improve significantly the appearance of the resulting crop.

On the other hand the incompleteness of the methods of disinfection used, may explain why in some parts of the country potatogrowers do not seem to derive any benefit from seed disinfection. Further experiments in such districts appear to be necessary.

Disinfection of soil by application of pentachloronitrobenzene (PCNB) at the rate of 60–90 kg active substance/ha considerably improves the appearance of the crop. Such treatment may be economical for growers of high quality potato seed if *Rhizoctonia* is a problem.

Broadcasting the chemical at the time of planting appears to be an effective method of application. In one experiment the effect of PCNB was completely suppressed by ploughing the land after broadcasting the powder. Application of PCNB or mercuric chloride retards emergence, which may result in loss of crop especially if the growing period is artificially shortened by haulm killing.

Depression of yield is most noticeable in the years when *Rhizoctonia* is not severe. If the disease is prevalent the retarding effect of PCNB and mercuric chloride is to a large extent compensated by the *Rhizoctonia* control obtained.

In those cases where observations were made as to the effect of time of harvest on the amount of black scurf on the tubers, it was found that *the number of sclerotia increased considerably with the time the tubers were left in the soil.*

Acknowledgement. Thanks are due to Dr. A. R. Wilson for correction of English text and helpful suggestions.

SUMMARY

CONTROL OF *RHIZOCTONIA SOLANI* Kühn IN POTATOES BY DISINFECTION OF SEED TUBERS AND BY CHEMICAL TREATMENT OF THE SOIL

1 Disinfection of seed tubers with proprietary organo-mercury compounds effectively controls *Rhizoctonia solani* in the seed potato growing area of Noord-Holland.

2 The beneficial effect of disinfection is also produced if the seedtubers do not bear sclerotia, because the fungus inoculum may be present as mycelial threads in the cavities around the eyes.

3 The methods of disinfection used did not

damage the germinative powers of the seed tubers.

4 Soil treatment with Pentachloronitrobenzene at 60–90 kg active substance per ha or with mercuric chloride at 16 kg/ha also controls *Rhizoctonia solani*. Broadcasting the chemicals at the time of planting is an effective method of application. If *Rhizoctonia* is not prevalent the treated plots show a delayed emergence as compared with the untreated; this may result in loss of crop.

5 The amount of black scurf occurring on the tubers increases with the time they are left in the soil.

ZUSAMMENFASSUNG

BEKÄMPFUNG VON *RHIZOCTONIA SOLANI* KÜHN IN KARTOFFELN DURCH DESINFIZIERUNG VON SAATKNOLLEN UND DURCH CHEMISCHE BEHANDLUNG DES BODENS

1 Desinfizierung von Saatknollen mit patentierten organischen Quecksilberverbindungen ist ein wirkungsvolles Bekämpfungsmittel für *Rhizoctonia solani* im Saatkartoffel-anbaugebiet Nordhollands.

2 Die günstige Wirkung der Desinfektion wird auch hervorgerufen, wenn die Saatknollen keine Skletorien tragen, denn die Pilzkeime können anwesend sein als Myzelfäden, in den Vertiefungen um die Augen herum.

3 Die angewandten Desinfektionsverfahren schädigten die Keimkraft der Saatknollen nicht.

4 Bodenbehandlung mit Pentachloronitrobenzen (60 bis 90 kg aktiver Stoff je Hektar) oder mit Quecksilberchlorid (16 kg je Hektar) kann ebenfalls zur Bekämpfung von *Rhizoctonia solani* dienen. Das Ausstreuen der Chemikalien in der Pflanzzeit ist eine effektvolle Anwendungsmethode. Wenn *Rhizoctonia* nicht vorherschend ist, dann zeigen die behandelten Parzellen ein verspätetes Auflaufen im Vergleich zu den unbehandelten Parzellen; dies kann zu Ernteverlusten führen.

5 Die Menge schwarzen Schorfs, die auf den Knollen vorkommt, nimmt zu in der Zeit, in der die Knollen in der Erde gelassen werden.

RÉSUMÉ

LA LUTTE CONTRE *RHIZOCTONIA SOLANI* KÜHN DANS DES CULTURES DE POMMES DE TERRE INFESTÉES PAR DÉSINFECTION DES PLANTS ET TRAITEMENT CHIMIQUE DU SOL

1 La désinfection de plants de pommes de terre par des combinaisons organiques de mercure se montre un moyen efficace dans la lutte contre le rhizoctone des tubercules de pommes de terre dans la province de Hollande septentrionale.

2 La désinfection a donné de bons résultats même dans les cas où les tubercules ne sont pas atteints par sclérotia, du fait que le champignon peut être présent dans les cavités autour des yeux sous forme de mycélium.

3 Les méthodes de désinfection pratiquées n'ont pas nui aux forces germinatives des plants.

4 Un traitement du sol à pentachloronitrobenzène contenant 60 à 90 kg de substance active à l'hectare, ou bien à chlorure mercurique à 16 kg par hectare, combat également la gale rhizoctonienne. Très efficace s'avère, au surplus, l'utilisation de produits chimiques au moment de la plantation. Lorsque les cultures ne sont pas infestées par la gale rhizoctonienne, les terres traitées démontrent une croissance tardive de la végétation en présence de témoins. Une perte partielle de la moisson peut en résulter.

5 Plus la période pendant laquelle la pomme de terre demeure dans le sol, est longue, plus la chance d'infestation des tubercules par la gale rhizoctonienne est grande.

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ASSESSMENT OF THE RESISTANCE OF POTATO VARIETIES TO COMMON SCAB[1]

R. K. McKEE [2]

Agricultural Research Council Potato Storage Investigation,
c/o, Nottingham University School of Agriculture,
Sutton Bonington, Loughborough, Leics

Summary in Eng., G. & Fr., p. 79

INTRODUCTION

Potato varieties differ greatly in their susceptibility to infection by *Streptomyces scabies* though none show complete immunity. An assessment of the susceptibility of a variety may be made by growing it in soil infested with a pathogenic strain of the organism and comparing the extent of infection on the tubers with that on standard varieties exposed under the same conditions. It is necessary to adopt some numerical system of scoring the incidence of infection if a quantitative comparison is required. Such systems have been based either on the proportion of tuber surface affected (cover), as described by CLARK, STEVENSON & SCHAAL (1938), LARGE (1955), EMILSSON & GUSTAFSSON (1953) and others, or on the type of scab lesion (LEACH, KRANTZ, DECKER & MATTSON, 1938; SCHAAL, 1944). STEVENSON, SCHAAL, CLARK & AKELEY (1942), who recorded cover and type of lesion separately, found a high degree of correlation between the two scores „indicating that in the majority of cases the relative reactions of the varieties could be estimated by either criterion".

A difficulty in devising a scoring system based on lesion characteristics is the wide range of types that occur. In Great Britain, MILLARD & BURR (1926) distinguished superficial (russet), ordinary, pitted, stud, tumulus and pimple scabs. In Sweden, EMILSSON & GUSTAFSSON (1953) recorded four classes: superficial, ordinary, deep and elevated; elevated lesions occurred quite frequently except on the most resistant varieties. STEVENSON *et al.* (1942) used only three pustule types in their widespread trials in the United States, 1) large and deep, 2) large but superficial, 3) small and superficial, suggesting that there elevated scabs were uncommon.

Numerous strains of *Streptomyces scabies* occur naturally in soil. It is generally agreed that these show a wide range in pathogenicity but opinions differ regarding both the occurrence of strains especially virulent towards specific varieties and of strains causing specific types of lesions.

LEACH, DECKER & BECKER (1939) and DE BRUYN (1939) both distinguished pathogenic

[1] Received for publication Jan. 9, 1958.

[2] Now at John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

races on the basis of the infection on a range of resistant varieties in pot tests; they suggested that the infection in the field of varieties previously considered resistant might be due to different races of the pathogen.

On the other hand, analysis of data from experiments where resistant varieties were grown in widely separated localities (STEVENSON *et al.*, 1942; EMILSSON & GUSTAFSSON, 1953) provided little evidence of differences in pathogenicity of the strains at the different sites to the varieties tested.

EMILSSON & GUSTAFSSON (1953) reviewed the literature on this question and concluded that „external conditions, including the possible occurrence of different strains of *Actinomyces*, play a relatively unimportant part in determining the order of scab resistance that must be assigned to certain potato varieties"; they also discussed the conflicting evidence on the relationship between the strain of pathogen and the type of scab lesion and decided that, at least for their own material, the host variety played a more important part in determining the type of scab than did local environmental conditions, including the strain of *S. scabies*.

Standard procedures for field tests of varietal resistance have been given by WALKER, LARSON & ALBERT (1938), STEVENSON *et al.* (1942) and LEACH *et al.* (1938) while MILLARD & BURR (1926), SCHAAL (1944), TAYLOR & DECKER (1947) and others have described methods for growing plants in soil or compost artificially contaminated with *S. scabies*. The latter method allows control over the strain of pathogen and, to some extent, over the environmental conditions if the experiment is carried out in the glasshouse.

Numerous investigators have searched for anatomical or chemical characters associated with resistance to scab, in order to overcome the lengthy procedure necessary in the direct estimation of resistance. Two indirect methods described recently are based on chlorogenic acid content (SCHAAL, JOHNSON & SIMONDS, 1953) and on the periderm development (COOPER, STOKES & RIEMANN, 1954).

The objects of the investigation reported here were firstly, to examine methods of assessing the scab resistance of potato varieties and secondly, to determine the extent to which estimates of varietal resistance depended on the virulence or physiological specialisation of the strain of the parasite involved.

MATERIALS AND METHODS

Resistant varieties. Samples of seed tubers of varieties resistant to scab were obtained originally from the following sources:

Dr. J. C. MOOI, Instituut voor Plantenziektenkundig Onderzoek, Wageningen, the Netherlands (Varieties Ackersegen, Erdgold).

PROF. DR. O. FISCHNICH, Institut für Pflanzenbau und Saatguterzeugung der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, Germany (Varieties Ackersegen, Erdgold, Frühperle, Monika, Panther).

PROF. R. H. LARSEN, Department of Plant Pathology, College of Agriculture, University of Wisconsin, Madison 6, Wisconsin, U.S.A. (Varieties Cayuga, Cherokee, Menominee, Ontario, Seneca, Yampa, S 330 [1], 303/40).

[1] Seedlings raised by DR. G. H. RIEMANN, Dept. of Genetics, University of Wisconsin.

Stocks of these varieties were kindly maintained in Northern Ireland by MR. J. C. CULLEN of the National Institute of Agricultural Botany, who provided each year the seed tubers required for the season's experiments.

Streptomyces scabies isolates. Isolations were made, using TAYLOR's method (TAYLOR 1936), from 35 samples of scabbed tubers collected by Area Supervisors of the Ministry of Food (Potato Division) from different localities throughout the British Isles. With the kind co-operation of MR. W. S. GREAVES, freeze-dried stock cultures of these isolates were prepared by the National Collection of Industrial Bacteria, Chemical Research Laboratory, Teddington; freeze-drying proved a satisfactory method of maintenance as there was no apparent loss of viability after five years' storage and the problem of retaining the characteristics of the original isolate over a series of subcultures was avoided.

Field experiments

Potatoes were grown at the Nottingham University School of Agriculture, on a site known from previous experience to produce crops severely affected by scab. A uniformity trial indicated that this area as a whole was evenly infested, although considerable variation was found in the incidence of scab on individual plants and on tubers of the same plant.

A randomized block layout was used for all trials and normal cultivations were given. The plots were separated in the drills by plants of the variety Arran Victory whose purple tubers facilitated identification of plot boundaries when harvesting.

Glasshouse experiments

Inocula were prepared from cultures grown on potato dextrose agar (0.5 % dextrose), adjusted to pH 7.0, in medicine bottles, the bottles being laid flat to expose a large surface of agar. Each bottle was seeded with 1 ml of a suspension prepared from a freeze-dried culture, the whole surface of the agar being flooded. After two weeks growth at approx. 25°C, the agar was broken up with a glass rod, a little water added, and the culture shaken out and homogenised in a blender; incorporation of agar in the suspension assisted in wetting the waxy spores. The suspension from each bottle was diluted to 400 ml and mixed with compost sufficient to fill twelve 4 in. pots.

Compost was prepared to the John Innes potting formula No. 1, except that the amount of chalk was doubled. In earlier experiments the loam and peat were sterilized by autoclaving on several successive days but steaming as in normal horticultural practice was found to kill off most of the *Streptomyces* spp. present and resulted in a better compost. Very good plant growth and infection were obtained in a trial where vermiculite (DIJKSTRA, 1956) was used as a substitute for the peat and loam.

Experiment showed that the incidence of scab was little influenced by the types of container in which the plants were grown; these included 6 in., 4 in. and 3 in. pots and seed trays 12 × 8 × 4 in., the pots containing one plant each and the trays either twelve or fifteen. The plants were grown from sprouting eyes which were excised from surface sterilized tubers about a week before planting, to allow time for suberization of the accompanying tuber tissues. Maximal infection was obtained in plants which had been watered when the pots „rang" when tapped, although there was still considerable infection when watering was either more or less frequent. It may be

noted that NOLL (1939) having found that „normal" watering completely inhibited infection, recommended that the soil (sandy loam) should be held at 20 % water capacity.

The plants were placed in separate blocks arranged so that each block included only one isolate. This layout reduced the risk of cross-contamination but prevented randomization of the replicates.

Scoring

The tubers were examined individually and classified both on the proportion of surface affected by scab (cover) and on the type of lesion. The cover system was based on that illustrated by LARGE (1955) and consisted of five categories to each of which was allocated an arbitrary score (Table 1).

In recording the type of scab, an estimate was made of the severity of damage, no account being taken of whether the lesions were „elevated" or „deep" but only of the distortion they caused; the proportion of surface affected was also ignored.

Five categories were employed and scores allocated corresponding to those for cover (Table 1).

TABLE 1. Categories used in assessing cover and damage and the corresponding scores

Proportion of surface affected *Grössenverhältnis der infizierten Bodenfläche*	Score *Punktzahl*	Damage *Schaden*
0 – 1/16	0	None (*Kein*)
1/16 – 1/8	1/2	Very slight (*Sehr leicht*)
1/8 – 1/4	1	Slight (*Leicht*)
1/4 – 1/2	2	Moderate (*Mässig*)
1/2 – 1	4	Severe (*Schwer*)

TABELLE 1. *Klassifizierung, angewandt bei der Feststellung des Befalls und des Schadens, mit Bewertung in Punktzahlen*

The scores for all the tubers from a plot were added and the mean score per ten tubers calculated.

Indirect methods of assessing scab resistance

Ferric chloride test. This test for scab resistance is stated by SCHAAL, JOHNSON & SIMONDS (1953) to indicate the chlorogenic acid content of the periderm. It consists of placing a small drop of a 2 % ferric chloride solution on the unwounded surface, scarifying with a stainless steel scalpel, and scoring the intensity of the blue colour developed.

Periderm test. (COOPER, STOKE & RIEMANN, 1954). Stained sections of the periderm of young tubers are examined and an estimate of number of dead cells obtained as a percentage of the total number of cells in the periderm. The dead cells could be distinguished as their nuclei had disintegrated.

RESULTS

Varietal resistance – field trials

The scoring methods were examined in an experiment in which the incidence of scab infection was recorded on six varieties selected to show a range in resistance (Table 2). Replication consisted of six blocks and each plot contained six plants.

TABLE 2. Scab infection on six varieties. Mean cover and damage scores per ten tubers

Variety *Sorte*	Cover Score *Befall*	Damage Score *Schaden*
Ackersegen	0.9	11.3
Erdgold	2.3	11.4
Red King	5.2	19.1
Arran Pilot	7.3	18.1
Duke of York	9.8	18.0
Redskin	14.5	26.6
S.E. (*Standardfehler*)	±0.45	±1.40

TABELLE 2. *Schorfbefall bei sechs Sorten. Mittlere Befalls- und Schadenzahlen je 10 Knollen*

Correlation coefficient (varieties) = 0.937, 4 D.F.
Korrelationskoeffizient (Sorten)

The cover and damage scores were highly correlated and the use of either permitted the separation of the varieties into resistant, susceptible and intermediate groups. The standard error was lower and the range of values greater in the cover scores so that the varieties could best be placed individually in order of susceptibility on this basis. In practice, the cover scores proved easier to record than the more subjective damage scores. However, in some field and many glasshouse experiments the incidence of infection was irregular and very low so that the majority of tubers fell in the category $0–^{1}/_{16}$ cover, giving a score of zero. In such experiments, scores based on damage were often higher and more useful than those based on cover.

The incidence of scab infection on introduced resistant varieties was compared over a four-year period with that on a number of British varieties, including the very susceptible variety Redskin and the variety Red King which is considered to be moderately resistant. The results of these experiments are given in Table 3.

Both damage and cover scores were recorded but the latter were not analysed statistically because of the predominance of low values.

The relative resistance of the varieties remained more or less constant, though each year there were a few deviations from the expected order. The degree of resistance shown by varieties such as Ackersegen and Cayuga was such that they consistently produced a clean crop under conditions where the more susceptible varieties were heavily scabbed.

In 1953, the tubers from five plants of each variety were examined as compared with

TABLE 3. Incidence of scab on potato varieties arranged in order of increasing susceptibility as indicated by mean damage score

Year (*Jahr*)	1953	1954	1955	1956	1953	1954	1955	1956
Blocks (*Blocks*)	6	5	5	5	6	5	5	5
Plants per plot (*Pflanzen je Beet*)	1	3	3	3	1	3	3	3
	Cover Score (*Befall*)				Damage Score (*Schaden*)			
Cayuga	0.0	0.1	0.0	0.0	3.8	6.7	2.6	9.2
Monika	–	–	0.0	0.0	–	–	1.8	9.7
Ackersegen	0.0	0.2	0.2	0.0	7.7	5.5	7.4	5.0
S 330	0.2	0.0	0.0	0.0	6.1	7.0	3.6	9.5
Frühperle	–	–	0.2	0.0	–	–	6.4	8.5
Erdgold	0.5	0.2	–	–	8.6	7.3	–	–
Seneca	0.1	0.2	0.3	0.0	7.2	7.8	8.4	8.6
Ontario	1.3	1.0	0.2	0.4	8.7	8.3	6.6	8.7
Menominee	2.0	5.5	0.1	1.0	8.1	8.3	7.8	8.5
303/40	2.9	1.0	0.2	0.1	9.9	8.5	6.8	8.6
Duke of York	0.8	–	–	–	9.1	–	–	–
Yampa	0.4	2.0	0.8	1.0	9.3	9.3	9.2	9.9
Panther	–	–	1.3	0.0	–	–	10.6	8.4
Cherokee	1.6	1.9	2.7	0.5	9.9	8.1	12.4	9.7
Red King	5.5	3.2	1.8	1.0	11.6	10.7	11.8	10.5
Arran Pilot	2.7	6.7	1.0	1.2	12.4	11.7	9.6	11.3
Majestic	–	10.1	7.0	5.3	–	13.6	18.6	15.9
Redskin	8.6	11.3	3.6	8.4	22.0	17.2	14.8	18.9
Standard Error ± *Standardfehler*					1.29	1.06	1.13	0.58

TABELLE 3. *Schorfbefall bei Kartoffelsorten, geordnet nach der zunehmenden Anfälligkeit auf Grund der mittleren Schadenzahl*

those from fifteen plants in subsequent years; the standard error in 1953 was therefore higher than in other years though still sufficiently low to allow the separation of the resistant varieties, which is all that is required in many „screening" trials.
There is some indication that the level of incidence of the disease fluctuated from one season to another, but this may have been partly due to failure to maintain absolute values of scoring from year to year.

Varietal resistance – glasshouse trials

The lack of precision in estimates of resistance due to irregular infection in field trials is aggravated in glasshouse tests by the difficulty of maintaining uniform conditions and by the smaller number of tubers obtained from each plant. Moreover, the conditions under which infection takes place in pot tests in the glasshouse differ greatly from those in the field. For this reason it could not be presumed that estimates

of resistance obtained in the two environments would prove consistent. The agreement between field and glasshouse assessments was therefore investigated by exposing two plants of each of the varieties included in the field trial of Table 2 to each of ten isolates of *S. scabies*. The means of the cover and damage scores are recorded in Table 4.

TABLE 4. Comparison of resistance of varieties as indicated by mean cover and damage scores, relative to score on Redskin, in field and in glasshouse tests

Variety *Sorte*	Cover Score (*Befall*)		Damage Score (*Schaden*)	
	Field *Feld*	Glasshouse *Haus*	Field *Feld*	Glasshouse *Haus*
Redskin	100	100	100	100
Duke of York	67	88	67	105
Arran Pilot	47	63	64	97
Red King	37	37	60	53
Erdgold	16	43	37	62
Ackersegen	5	13	35	37

TABELLE 4. *Vergleichung der Resistenz von Sorten, wie in der Aufstellung von mittleren Befall- und Schadenzahlen angegeben, im Verhältnis zu Redskin, in Feld- und Gewächshausversuchen*

Agreement between the scores based on cover was good but the damage scores only allowed the separation of the varieties into groups which showed some overlapping. In another glasshouse trial, one plant of each of fourteen of the varieties included in the field test of Table 3 was exposed to infection by each of thirty isolates (Table 5).

TABLE 5. Comparison of resistance of varieties as indicated by mean cover and damage scores in field and glasshouse tests

Variety *Sorte*	Cover Score (*Befall*)		Damage Score (*Schaden*)	
	Field *Feld*	Glasshouse *Haus*	Field *Feld*	Glasshouse *Haus*
Cayuga	0.0	1.2	5.6	3.6
Ackersegen	0.1	0.1	5.8	2.7
S 330	0.0	1.0	6.4	3.4
Erdgold	0.3	1.7	7.9	4.5
Seneca	0.2	2.7	8.0	5.6
Ontario	0.7	1.2	8.1	3.5
Menominee	2.1	8.4	8.2	8.8
303/40	1.1	11.5	8.4	12.1
Yampa	1.1	8.7	9.4	9.0
Cherokee	1.7	2.6	10.0	7.6
Red King	2.9	7.0	11.1	9.5
Arran Pilot	2.9	5.9	11.3	12.2
Majestic	7.5	12.1	16.0	11.8
Redskin	8.0	15.6	17.8	15.4

TABELLE 5. *Vergleichung der Resistenz von Sorten, wie in der Aufstellung von mittleren Befall- und Schadenzahlen angegeben, in Feld- und Gewächshausversuchen*

Correlation coefficients between the pairs of cover and damage scores were 0.85 and 0.84 respectively, indicating quite good agreement when the small number of plants in the glasshouse trial is considered.

Varietal resistance – indirect methods

Periderm test. Observations were made on the periderm of tubers of the varieties indicated in Table 6, using the method described by COOPER, STOKES & RIEMANN (1954).

TABLE 6. Proportion of dead cells in tuber periderm expressed as percentage of total number of periderm cells. (Two estimates per variety)

Variety (resistant) *Sorte (resistent)*	% dead cells *Prozentsatz tote Zellen*	Variety (susceptible) *Sorte (anfällig)*	% dead cells *Prozentsatz tote Zellen*
Panther	1, 3	Arran Victory	13, 12
Cayuga	6, 4	King Edward	10, 21
Erdgold	3, 10	Red King	21, 19
Yampa	10, 4	Arran Pilot	16, 33
Ontario	8, 7	Redskin	26, 35
Cherokee	14, 12	Keswick	31, 38
Ackersegen	26, 25		
Frühperle	40, 38		

TABELLE 6. *Verhältnis der tote Zellen im Periderm der Knollen, ausgedrückt als Prozentsatz der Gesamtzahl Peridermzellen (zwei Schätzungen je Sorte)*

The susceptible varieties all had high scores while the resistant varieties had low scores except for Ackersegen and Frühperle whose scores were as high as most of those in the susceptible group.

Ferric chloride test. The test described by SCHAAL, JOHNSON & SIMONDS (1953) was carried out on tubers of a number of varieties (Table 7).

TABLE 7. Colour scores in ferric chloride test for twenty-two varieties (0 = no colour, 3 = dark colour)

Score *Farbton*	Varieties *(Sorten)*	
	Susceptible *Anfällig*	Resistant *Resistent*
3.0	Ulster Supreme, Arran Victory	Ontario, 303/40
2.5	Keswick	Seneca, Monika, Cayuga, Ackersegen
2.0	Redskin, Kerr's Pink, Majestic	Frühperle, Panther, S 330
1.5	Arran Pilot, King Edward	Menominee
1.0		Erdgold, Yampa, Cherokee
0.0	Red King	

TABELLE 7. *Farbenabstufung im Eisenchloridversuch für zweiundzwanzig Sorten (0 = keine Färbung; 3 = dunkle Färbung)*

There was no evidence of a correlation between colour score and resistance.

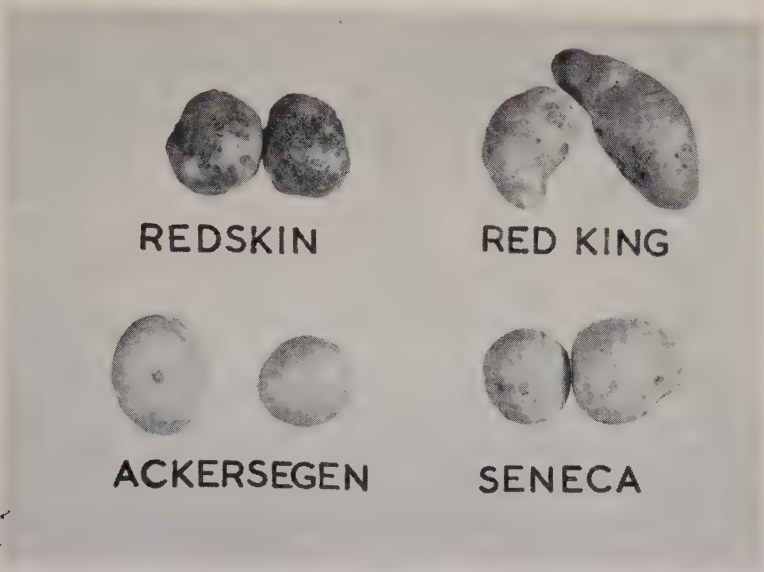

FIG. 1. INFECTION ON TUBERS GROWN IN COMPOST INFECTED WITH *Streptomyces scabies* (ISOLATE 51)
FIG. 1. *Schorfbefall auf Knollen, gewachsen in mit Streptomyces scabies infiziertem Kompost (Zuchtstamm* 51)

PATHOGENICITY OF STREPTOMYCES SCABIES ISOLATES

Thirty isolates of *S. scabies* were investigated to determine their range of pathogenicity and the extent of physiological specialisation on the resistant varieties available. Although most of the isolates were similar in appearance and agreed with the published description of *S. scabies* (WAKSMAN & LECHEVALIER, 1953) they could be distinguished one from another when cultures grown under identical conditions were compared. Differences were, however, slight and difficult to describe. Some of the weakly pathogenic isolates differed in not producing a brown diffusible pigment on potato dextrose agar and a few differed in the colour of the colony.

The mean cover scores for the thirty isolates on fourteen varieties of potatoes are given in Table 8 and may be taken as an indication of the range of pathogenicity likely to occur. One plant of each variety was exposed to infection by each isolate and all the tubers were examined.

Most of the isolates scoring 0 (0–$^1/_{16}$ cover) produced occasional lesions, fresh isolates from which were found to be identical in appearance with the culture used for inoculation. They were therefore regarded as weakly pathogenic rather than avirulent.

No evidence of infection due to contamination by more pathogenic isolates was found in the tubers grown in compost inoculated with weakly pathogenic isolates, despite the fact that the surface of the compost was exposed. Re-isolations were attempted from a sample of lesions from all isolates and comparison of the cultures thus obtained showed that the great majority conformed in appearance to the originals.

TABLE 8. Distribution of pathogenicity among thirty isolates of S. scabies

Mean cover score *Mittelzahl des Befalls*	No. of isolates *No. des Zuchtstamms*
0	10
0.1–0.5	5
0.6–1.0	9
1.1–1.5	3
1.6–2.0	2
2.0	1

TABELLE 8. *Verteilung der Pathogenität unter dreissig Zuchtstämmen von Streptomyces scabies*

A correlation between pathogenicity and the ability of *S. scabies* isolates to produce a brown diffusible pigment on organic media has been recorded by various authors. Some of the pathogenic and weakly pathogenic isolates were compared in a liquid milk medium (TAYLOR & DECKER, 1947). The results are given in Table 9.

TABLE 9. Colour of surface growth of twenty isolates of *S. scabies* after ten days' growth at 25 °C on a liquid milk medium
(+ = marked colour, (+) = slight colour, — = no colour)

Isolate No. (Pathogenic) *No. des Zuchtstamms (pathogen)*	Colour *Farbe*	Isolate No. (Weakly pathogenic) *No. des Zuchtstamms (schwach pathogen)*	Colour *Farbe*
1	+	2	—
3	+	4	—
29	+	37	(+)
36	+	39	(+)
40	+	41	(+)
42	+	44	+
45	+	46	—
51	(+)	47	—
54	+	59	—
58	+	60	—

TABELLE 9. *Farbe des Oberflächenwuchses bei zwanzig Zuchtstämmen von S. scabies nach zehntägiger Entwicklung bei 25 °C auf einem flüssigen Milchmedium* (+ (+ = *ausgeprägte Farbe;* (+) = *heller Farbton;* — = *keine Farbe*)

Although there were a few exceptions, agreement between the two properties was good, indicating that colour production should prove a useful character for the selection of isolates for resistance tests.

Comparison of the pathogenicity of isolates in different years (Table 10) showed that the estimate was moderately stable, the majority of isolates remaining in the same arbitrary pathogenicity group; the correlation coefficient between the 1954 and 1955 scores was 0.83. The scores in Table 10 were made on the produce of three plants of each variety.

TABLE 10. Pathogenicity of *S. scabies* isolates in two successive years as indicated by sum of mean cover scores on the five varieties, Redskin, Red King, Ontario, Ackersegen and Seneca

Arbitrary pathogenicity group *Willkürliche Pathogenitätsgruppe*	Isolate *Zuchtstämme*	1954	1955
1	7	68	43
	29	63	37
	51	47	47
	1	47	24
	42	53	16
	45	47	18
	10	74	11
2	8	31	18
	3	15	31
	40	40	14
	58	43	12
	9	26	10
	6	19	13
	43	11	12
3	37	8	13
	27	8	7
	5	5	5
	2	1	2
	46	1	1
	60	4	0
4	41	0	1
	47	0	1
	4	0	0
	44	0	0
	39	0	0
	57	0	0
	59	0	0

TABELLE 10. *Pathogenität von S. scabies Zuchtstämme in zwei aufeinanderfolgenden Jahren, wie angegeben durch die Summe der mittleren Befallzahlen bei den fünf Sorten Eedskin, Red King, Ontario, Ackersegen und Seneca*

The pathogenicity of the isolates to individual varieties was investigated in a number of experiments. Fig. 2 is typical of the results obtained, which gave no indication of physiological specialisation.

Data from a similar experiment, employing fewer varieties but more replication, are presented in Table 11, the ten weakly pathogenic isolates being omitted from the Table.

TABLE 11. Susceptibility of five potato varieties to twenty isolates of *S. scabies*, relative to the susceptibility of the variety Redskin. Isolates arranged in order of increasing virulence (6 plants of each variety exposed to each isolate)

Isolate *Zuchtstamm*	Cover Score for Redskin *Befallzahl Redskin*	Relative cover score, Redskin = 100 *Relativer Befall, Redskin* = 100			
		Red King	Ontario	Seneca	Ackersegen
5	0.2	90	0	0	0
37	0.5	25	20	0	5
43	0.6	55	10	0	0
6	0.6	30	200	0	0
27	0.7	0	0	0	0
36	0.8	40	30	0	15
61	0.8	25	63	0	0
3	1.1	20	15	0	0
54	1.1	65	20	40	50
8	1.3	55	55	30	0
45	1.4	125	75	35	10
40	1.4	45	95	10	28
10	1.7	155	130	45	27
9	1.8	35	5	0	5
58	1.8	30	80	35	0
42	2.0	65	60	25	10
29	2.2	65	90	35	5
7	2.3	55	55	50	30
1	2.6	40	40	0	0
51	2.8	35	20	10	5

TABELLE 11. *Anfälligkeit von fünf Kartoffelsorten für zwanzig Zuchtstämme von S. scabies, im Verhältnis zur Anfälligkeit der Sorte Redskin. Die Stämme geordnet nach der zunehmenden Virulenz (je 6 Pflanzen von jeder Kartoffelsorte waren jedem abgesonderten Zuchtstamm des Schorfs ausgesetzt)*

The average resistance of the varieties to all isolates indicated that their resistance increased in the order Redskin, Red King, Ontario, Seneca, Ackersegen. Consideration of the results for the individual isolates shows that the varieties fell in the expected order in 87 out of the 100 trials; few of the deviations which were found when the experiment was repeated the following year coincided with those in Table 11. In general, virulence to the more resistant varieties was associated with high virulence to the other varieties. For example, 60 % of the isolates with a score of over 1.0 on Redskin infected both Ackersegen and Seneca while none of the seven isolates with a score of less than 1.0 did so.

Although no account was taken of the type of scab lesion when assessing the damage score, descriptive notes were made when examining each tuber. Ordinary, pitted and elevated lesions were found on tubers grown in the field, sometimes all three types on the same tuber. In the glasshouse, infection with some isolates resulted mainly in the production of ordinary lesions; with other isolates, usually those of higher pathogenicity, ordinary, pitted and elevated lesions were found, the type pre-

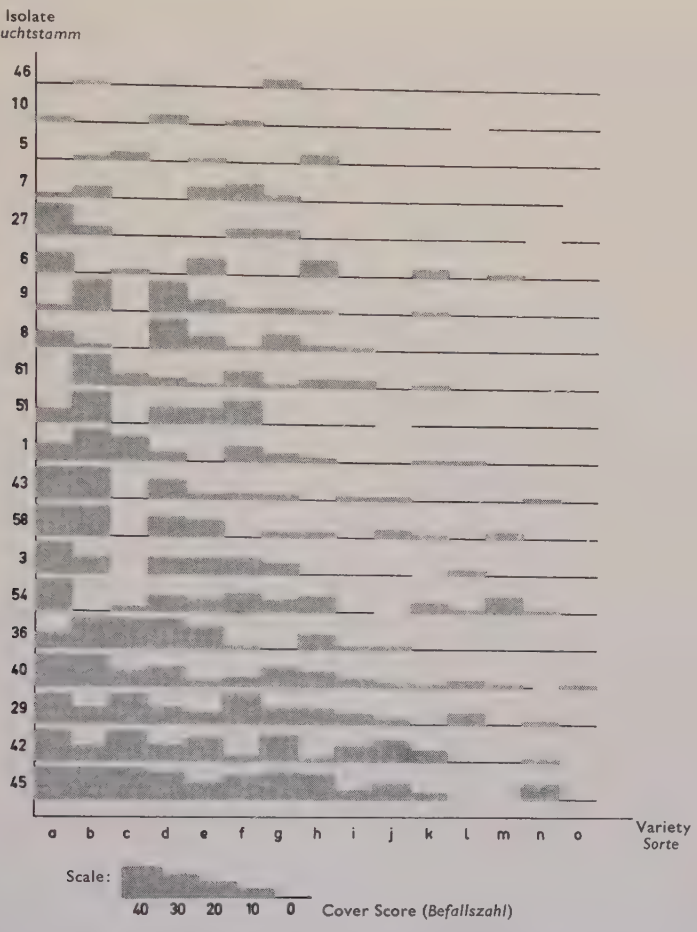

FIG. 2. INFECTION (TOTAL OF THE COVER SCORES OF TEN TUBERS) ON FOURTEEN POTATO VARIETIES AFTER EXPOSURE TO TWENTY ISOLATES OF *S. scabies*.
Ten other isolates included in the experiment gave a score of 0 on all the varieties.
Varieties a, b Redskin; c, Majestic; d, 303/40; e, Yampa; f, Menominee; g, Red King; h, Arran Pilot, i, Seneca; j, Cherokee; k, Endgold; l, Cayuga; m, Ontario; n, 330; o, Ackersegen

FIG. 2. *Schorfbefall (je zehn Kartoffelknollen) bei vierzehn Kartoffelsorten nach infizierung mit zwanzig Zuchtstämme von S. scabies.*

dominating appearing to depend on the variety. Lesions of more than one type were, however, often found on single tubers, even though these had been exposed only to one isolate.

DISCUSSION

The most practicable method of reducing losses caused by common scab is by the use

of resistant varieties and the main purpose of the work described was to investigate problems of importance in the selection of such varieties.

Numerical assessment of the resistance of varieties did not present any great difficulty provided that precise estimates were not required. Field trials are simpler to carry out than glasshouse trials but have the disadvantage that, if they are laid down in a single locality, the plants are exposed to infection only by the strain, or strains of *S. scabies* present there though this may not be of great importance if the strain is highly virulent. Further disadvantages in the field are that the environmental conditions are uncontrolled, that the season during which tests can be made is limited, and that the plants may become infected with virus diseases. A range of isolates can be included by growing plants in artificially infected compost in the glasshouse and some control over environment can also be obtained. Varietal resistance assessed in this manner was closely correlated with that found in the field trials. It may be noted that the methods described also proved suitable for assessing resistance in progenies from crosses involving scab resistant varieties and in lines of *Solanum andigenum*.

Separation of resistant and susceptible varieties was not achieved using either of the two indirect methods tested, though the periderm test gave a high proportion of successes. The ferric chloride test is reported as giving satisfaction in the United States, but in Sweden EMILSSON (1953) found no correlation between the chlorogenic acid content of the periderm and scab resistance. A recent record of infection of detached tubers (LAWRENCE, 1956) is of interest as it was previously considered that typical lesions developed only on tubers attached to the plant and increasing in size (FELLOWS, 1927).

Information on the extent to which physiological specialisation, in relation to host resistance, occurs in *Streptomyces scabies* is of obvious importance in the selection of scab resistant varieties. The isolates examined varied greatly in their pathogenicity but no evidence of physiological specialisation was obtained. It is possible that such evidence might be found if more isolates were tested or if pathogenicity could be measured more accurately. Moreover, many of the resistant varieties against which the isolates were tested had a common ancestry, deriving their resistance originally from the variety Richter's Jubel. However, until there is positive evidence to the contrary, it would seem reasonable to assume that varieties which have proved resistant when exposed to highly pathogenic strains in one locality will continue to demonstrate resistance when grown in other localities.

Scab resistance was the only property recorded in the field trials but many of the imported resistant varieties cropped sufficiently well to suggest that the suitability of their other agronomic properties for use in Britain should be investigated. The appearance of the produce from the resistant varieties was in striking contrast to that from the British varieties and might well have compensated for some deficiencies in yield or quality.

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SUMMARY

ASSESSMENT OF THE RESISTANCE OF POTATO VARIETIES TO COMMON SCAB

Field and glasshouse methods of assessing the resistance of potato varieties to common scab were investigated and procedures which were found to give satisfactory results are described in detail. Estimates of resistance for individual varieties in the two environments were closely correlated.

Examination of a number of isolates of *Streptomyces scabies* showed that these varied greatly in virulence but no evidence of physiological specialisation was found.

ZUSAMMENFASSUNG

FESTSTELLUNG DER RESISTENZ VON KARTOFFELSORTEN GEGEN SCHORF

Feld- und Gewächshausmethoden zur Feststellung der Resistenz von Kartoffelsorten gegen Schorf wurden untersucht. Verfahren, die zufriedenstellende Resultate ergaben, sind in Einzelheiten beschrieben. Die Schätzungen der Resistenz bei den einzelnen Sorten in den beiden Umgebungen standen in enger Wechselbeziehung zu einander.

Die Prüfung einer Anzahl Absonderungen von *Streptomyces scabies* ergab, dass diese in Virulenz stark variierten; aber es wurde kein Fall von physiologischer Spezialisierung gefunden.

RÉSUMÉ

L'ÉVALUATION DE LA RÉSISTANCE À LA GALE COMMUNE DE VARIÉTÉS DE POMMES DE TERRE

Des méthodes d'évaluation de la résistance à la gale commune de variétés de pommes de terre ont fait l'objet d'investigations en plein champ et en serre, alors que les modes opératoires donnant des résultats satisfaisants, ont été décrits en détail. Une corrélation étroite a été établie entre les estimations de la résistance pour chacune des variétés distinctes, placées dans les deux ambiances. L'examen de quelques cas isolés de *Streptomyces scabies* a démontré une grande variation dans la virulence sans qu'une preuve de spécialisation physiologique ne fût fournie.

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8. Les références doivent être données par ordre alphabétique à la fin de l'article suivant le "système de Harvard", comme suite: nom et initiales du prénom de l'auteur; année de publication entre parenthèses, au besoin accompagnée de minuscules a, b, c etc... en cas de pluralité d'articles d'une même année et du même auteur; titre exact de l'article; abréviation du titre du périodique conformément à la *Liste Mondiale de Périodiques Scientifiques:* numéro du volume en chiffres arabes; première et dernière page de l'article. Dans le texte les références sont données entre parenthèses en faisant suivre le nom de l'auteur de la date de publication, par ex: (SMITH, 1945), (SMITH 1947a; JONES ET SMITH 1942 a, b). Les références faisant intervenir plus de deux coauteurs sont seulement données intégralement à la première citation, les suivantes ne mentionnant que le premier nom suivre de *et al.*
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9. L'auteur reçoit la première épreuve pour correction. Vingt-cinq tirés à part de chaque article lui sont délivrés gratuitement. Ceux-ci et les tirés à part supplémentaires peuvent être obtenus en remplissant la formule qui accompagne les épreuves.

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